

Site: medley Farm
EPA: 6.8

MEDLEY FARM SITE

REMEDIAL DESIGN AND REMEDIAL ACTION

Performance Standards Verification Plan

Prepared for the
Medley Farm Site Steering Committee

By



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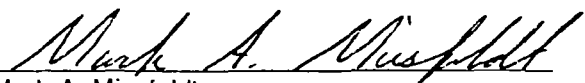
**MEDLEY FARM SITE
GAFFNEY, SOUTH CAROLINA**

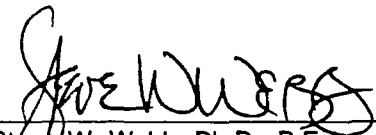
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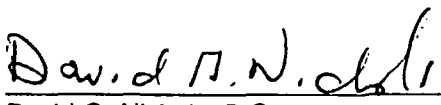
**PERFORMANCE STANDARDS VERIFICATION
FIELD SAMPLING AND ANALYSIS PLAN**

May 1993

*Prepared for the
Medley Farm Site Steering Committee*


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Section 1 INTRODUCTION

The Medley Farm property consists of 61.9 acres of rural land located approximately six miles south of Gaffney, South Carolina in Cherokee County. The Medley Farm Site (Site) as defined in the Record of Decision, occupies approximately seven acres of the 61.9 acre tract. The location of the Medley Farm property and Site are shown on Figure 1-1. Land surrounding the site is primarily pasture land and forest. Land use in the area is primarily agricultural and light residential. No change in land use of the Medley Farm property is expected in the near future.

1.1 Background

The Medley Farm property is currently owned by Ralph C. Medley, who acquired the property from William Medley in 1948. Prior to the mid-1970s, the property was maintained as undeveloped woodlands and pasture. Based on available information, the disposal of drummed and other solid waste materials at the Site began in 1973 and was terminated in June 1976. The South Carolina Department of Health and Environmental Control (SC DHEC) visited the Site in 1983. At the time of this visit, SC DHEC estimated that approximately 2,000 55-gallon drums were present on-site. Drums were found in open pits, several small lagoons, and scattered on the ground. In addition to the 55-gallon drums, there were numerous plastic containers of various sizes. No formal records regarding the drummed waste materials were maintained by either the property owner or the Principal Responsible Parties (PRPs).

SC DHEC informed the U.S. Environmental Protection Agency (US EPA) of site conditions and US EPA visited the Site to collect samples of the soil for analysis. An immediate removal action was subsequently initiated by the US EPA pursuant to Section 104 and other provisions of the Comprehensive Environmental Response, Compensation, and Liability act of 1980 (CERCLA). A total of 5,383 55-gallon drums and 15-gallon containers were removed from the Site. Affected solid waste and soils, totaling 2,132 cubic yards, were taken to an approved hazardous waste landfill for disposal. This interim remedial action was completed on July 21, 1983.

SC DHEC revisited the Site in 1984 to perform additional site investigations and install a ground water monitoring well (MD2A). Soil samples from two boreholes and a ground water sample collected from the newly installed monitoring well were analyzed for volatile organics, drinking water metals, and acid and base-neutral organic compounds. The results of the soil analyses identified the presence of methylene chloride and 1,2-dichloroethane at depths up to 10 feet. Results from ground water sampling events conducted in April 1984 and July 1984 are presented in Table 1-1.

The Medley Farm Site was proposed for inclusion on the National Priority List (NPL) in June 1986 and was finalized on the NPL in March 1990. The Remedial Investigation (RI) was conducted on behalf of the Medley Farm Site Steering Committee (MFSSC) by Sirrine Environmental Consultants (SEC) and occurred in two phases. Phase I began in January 1988 and ended with the submission of a draft RI report in March 1990. To address data gaps identified during the Phase I RI, a Phase II RI was conducted. A revised RI report including Phase II results, was submitted to US EPA in November 1990. The Feasibility Study (FS) for the Medley Farm Site was delivered to the US EPA in December 1990. In 1991, the US EPA approved both the RI and the FS and issued their Record of Decision (ROD) for the Medley Farm Site. Subsequently, the US EPA and the MFSSC agreed to conduct additional work designed to investigate ground water quality in the northwest quadrant of the site, as well as initiate the Remedial Design (RD) and Remedial Action (RA) process for the Site.

1.2 Purpose

The purpose of the Performance Standard Verification Plan (PSVP) is to develop and provide the mechanism for verification that both short-term and long-term performance standards established for the RA are being met. The Performance Standards Verification Plan consists of two parts: Performance Standards Verification Field Sampling and Analysis Plan (PSVFSAP) and Performance Standards Verification Quality Assurance Project Plan (PSVQAPP).

The purpose of the PSVFSAP is to establish data collection activities which are compatible with the remedial objectives for this project, and to provide a mechanism for evaluating the effectiveness of the ROD-selected remedies. The PSVFSAP provides a description of the data gathering activities, including methods, locations, frequency, equipment, and handling and analysis. The PSVQAPP is submitted along with the PSVFSAP to document quality assurance measures that will be utilized in conjunction with the Performance Standards Verification Plan.

TABLE 1-1
SC DHEC VOLATILE ORGANIC GROUND WATER ANALYSES

ANALYTICAL RESULTS FROM SC DHEC WELL MD2A	ANALYTICAL RESULTS (mg/L)	
	APRIL 13, 1984 (1)	JULY 18, 1984 (2)
methylene chloride	0.039	0.009
1,1-dichloroethene	1.887	1.645
1,1-dichloroethane	0.161	0.044
trans-1,2-dichloroethene	0.038	0.028
chloroform	0.008	0.004
1,2-dichloroethane	0.022	0.008
1,1,1-trichloroethane	3.362	2.188
carbon tetrachloride	3.804	0.830
trichloroethene	0.007	0.003
1,1,2-trichloroethane	0.067	0.015
toluene	0.030	***
perchloroethylene	0.003	***

*** No value given in SC DHEC analytical results.

References: 1. Workman, 1984(a)
2. Workman, 1984(b)

1.3 Scope

The Scope of this PSVFSAP is based on the following key project documents:

- US EPA Consent Decree and Statement of Work,
- Medley Farm Site Record of Decision,
- The EPA-approved Medley Farm Site RI and FS,
- The EPA-approved Medley Farm Site RD/RA FSAP and QAPP, and
- The Medley Farm Prefinal/Final Design Report.

The data collection activities described in Section 3 of this PSVFSAP are designed to address requirements stated by the US EPA in the Record of Decision and Consent Decree for monitoring the performance of the ground water and soil vapor extraction systems. The scope of these performance monitoring activities includes the following:

- Convert former extraction well A-1 to a performance monitoring well by retrofitting the existing borehole with a Waterloo multi-level well.
- In addition to the multi-level well at former well A-1, install two additional multi-level wells to monitor the effectiveness of the ground water extraction system at locations downgradient of the treatment system.
- Collect ground water quality samples from select site monitoring wells as part of the performance monitoring plan outlined in Section 3 of this PSVFSAP.
- Obtain water level measurements from on-site wells and staff gauges at the frequency stated in Section 3 of this PSVFSAP.
- In accordance with the NPDES permit, conduct chronic toxicity testing on the treated ground water prior to its discharge into Jones Creek.
- Conduct performance monitoring of the treated ground water effluent in accordance with the NPDES permit.
- Conduct performance monitoring of the soil vapor extraction system to evaluate system performance.

Section 2

SAMPLING OBJECTIVES

The data gathering and analytical activities proposed herein are intended to monitor the performance of the ground water and soil vapor extraction systems. The data gathered from these activities must be of sufficient quantity and quality to allow the Remedial Design and Remedial Action (RD/RA) to be conducted efficiently.

The following objectives have been developed for Performance Standard Verification Monitoring.

- Evaluate the effectiveness of the ground water extraction system in meeting the ROD stated remediation goals of restoring the ground water to drinking water quality.
- Evaluate the effectiveness of the soil vapor extraction system in removing VOC from the vadose zone such that it no longer presents a long-term source of contamination to the ground water.
- Further characterize Site hydrogeologic and geologic parameters that may influence the performance of the remedial systems as designed.

Data collection efforts may be identified to fill data gaps identified during the RD/RA process. This phased sampling approach is intended to enable a thorough review of the existing data and to permit collection of additional data relevant to evaluating the performance of the remedial systems installed at the Site.

Section 3
PERFORMANCE VERIFICATION SAMPLING

3.1 NPDES Effluent Monitoring

On May 13, 1993, SC DHEC issued NPDES Permit No. SC0046469, in draft form, addressing the monitoring and reporting requirements for the Medley Farm ground water remediation system. The requirements of this permit include:

3.1.1 Flow Monitoring

The treated effluent flow from the ground water treatment system will be continuously monitored using a recording flow meter. The remedial design calls for this flow metering device to be located immediately down stream of the air stripping system. This device will continuously monitor flow prior to the 001 effluent discharge into Jones Creek. Flow records will be available on a 24-hour basis in digital format.

3.1.2 Water Quality Monitoring

Water quality monitoring of the treated effluent will be conducted in accordance with the requirements of NPDES Permit No. SC0046469. This permit calls for sampling and analysis of the following analytical parameters:

<u>Sampling Parameter</u>	<u>SC DHEC Discharge Limitations (mg/L)</u>	
	<u>Monthly Avg.</u>	<u>Daily Max.</u>
1,2-Dichloroethane	MR	0.028
1,1-Dichloroethene	MR	0.039
Tetrachloroethene	MR	0.072
Trichloroethene	MR	0.028
BOD ₅	10	20.0

NOTES:

pH shall not be less than 6.0 standard units nor greater than 8.5 standard units.

MR - Monitor and Report Results

Samples shall be collected at a point immediately down stream of the treatment system and above the 001 effluent discharge to Jones Creek. Samples will be analyzed in accordance with the provisions of NPDES Permit No. SC0046469 and the Medley Farm PSVQAPP.

3.1.3 Biological Monitoring

The Medley Farm RD calls for construction of an in-stream diffuser within Jones Creek to better distribute the treated effluent within the creek and minimize point source effects. Since an in-stream diffuser has been included in the design, the NPDES Permit provides for periodic biological monitoring of the treated effluent. This program will include a three-brood chronic toxicity test on treated effluent collected at a point following treatment, but prior to discharge into Jones Creek. Chronic toxicity testing will be conducted using a control at an in-stream waste concentration (IWC) of 72%. Ceriodaphnia dubia will be utilized as the test organism.

The monitoring frequency for Whole Effluent Chronic Toxicity Testing called for in the draft NPDES permit is currently monthly. This is a permit requirement that is consistent with monitoring a conventional industrial effluent. Since the treated effluent from the Medley Farm remediation system is ground water that has been air-stripped, RMT has proposed an alternative sampling frequency for chronic toxicity testing.

For a ground water remediation, the highest VOC concentrations in the influent are typically encountered during the early stages of the treatment operations. VOC concentrations then fall off to an asymptotic value determined by many site- and chemical-specific conditions. In view of this, RMT believes monthly chronic toxicity testing is reasonable, but only insofar as it is continued until three consecutive tests successfully pass the NPDES permit criteria. At this time, the testing program would be reduced to quarterly testing at the Department's discretion.

In the event that chronic toxicity tests for one calendar year "pass", the Department may terminate the screening process and impose a limitation. This change is justified since jet-pump extraction involves a high degree of dilution and equalization of affected ground water prior to its discharge to the air-stripping system. This dilution and equalization readily attenuate wide variations in the water quality of the effluent stream.

This chronic toxicity testing program will be conducted by a lab certified by SC DHEC to conduct such testing. All tests will be conducted in accordance with NPDES Permit No. SC0046469 and RMT's existing QA/QC program.

3.1.4 Sample Location and Frequency

Samples addressed under the provisions of this section will be collected at a sampling point located immediately following the ground water treatment system and prior to discharge of the effluent to Jones Creek. The prescribed frequency for these tests follows:

<u>Sampling Parameter</u>	<u>SC DHEC Monitoring Requirements</u>	
	<u>Frequency</u>	<u>Sample Type</u>
Treated Effluent Flow	Continuous	Recording Flow Meter
pH	2/Week	Grab
1,2-Dichloroethane	Weekly	Grab
1,1-Dichloroethene	Weekly	Grab
Tetrachloroethene	Weekly	Grab
Trichloroethene	Weekly	Grab
BOD ₅	2/Month	Grab
Whole Effluent Chronic Toxicity Testing	Monthly	Grab

3.1.5 Reporting Requirements

Monitoring results obtained during each month's sampling and testing activities will be input and reported to SC DHEC on a Discharge Monitoring Report Form (EPA Form 3320-1). Two copies of these reports will be submitted prior to the 28th day of each subsequent month following start-up to the following address:

South Carolina Department of Health and Environmental Control
ATTN: BWPC/Enforcement Section
2600 Bull Street
Columbia, SC 29201

Records pertaining to this program will be retained for a minimum period of three years. US EPA will be provided copies of all such data upon receipt of a written request for same.

3.2 Soil Vapor Extraction System Monitoring

In accordance with an air emissions waiver issued by the SC DHEC Bureau of Air Quality Control, dated December 29, 1992, there are no SC DHEC regulatory requirements for air quality testing of either the SVE or ground water treatment systems. There are, however, several engineering and performance-related issues that need to be tracked and documented during the operating history of the SVE unit. A brief discussions of these various considerations follows:

3.2.1 Vacuum Unit Performance

The vacuum unit for the SVE system has been specifically designed to extract soil vapor from the three areas referred to in the Medley Farm ROD as Areas 1, 2, and 3. While the operational status of the vacuum unit will be checked on a routine basis by the assigned system operator, it is important that the overall performance of the vacuum unit also be periodically evaluated to confirm that remedial objectives are being met.

This routine performance evaluation includes collection of the required data to fill out the Vacuum Unit Performance Table. This table has been developed to summarize key operating parameters such as temperature, vapor flow rates, vacuum measurements, and vapor sampling results. A copy of the Vacuum Unit Performance Table is provided in Appendix A.

The data collected on the Vacuum Unit Performance Table will be evaluated to address:

- Replacement of air filters,
- Adjustments to applied vacuum levels,
- Adjustments to make-up air intake rates,
- Monitor emission rates, and
- Calculate mass removal.

3.2.2 Extraction Well Monitoring

It is important for the system operator to understand how each of the extraction wells responds to the applied vacuum. Extraction well monitoring involves measurement of the applied vacuum at the well-head. System performance curves can then be prepared so that the operator can quickly extrapolate SVE system performance based upon the current operating level of the vacuum pump. Extraction well monitoring includes:

- Development of a SVE well production curve from start-up data, and
- Monitoring of applied vacuum and vapor flow rates at each well head.

A plot of applied vacuum versus vapor flow rate will be developed for each extraction well. These plots will be used as tools to optimize VOC recovery at each well head. Data points for each of these plots will be obtained by incrementally increasing the applied vacuum on each of the well heads (step-wise), monitoring the response at the well head, and continuing on until the desired operating vacuum is reached.

During this step-wise testing, a Vacuum Unit Performance Table will be completed and the applied vacuum and vapor flow rates will be measured at each SVE well. Data obtained from extraction well readings will also be recorded on the Well Production Log, a copy of which is provided in Appendix A. Data from this log may be plotted and used to evaluate and assess vapor flow rates during the remediation.

3.2.3 Vacuum Monitoring Wells (VMs)

Vacuum monitoring wells were installed at strategic locations and depths to evaluate the areal and vertical extent of the applied vacuum within the site soils. VMs have been installed as nested wells to permit the site operator to periodically collect data regarding the vacuum level imposed at different depths and locations across the site. Vacuum monitoring wells will be monitored during start-up operations and through-out the operational life of the SVE system. Vacuum readings taken at the VMs will be recorded on a Vacuum Monitoring Log, as shown in Appendix A.

3.2.4 Vacuum Vapor Analyses

There are three different types of SVE discharge analyses that may be performed at the Medley Farm Site, including:

- Effluent VOC stack measurements,
- Influent VOC measurements at the vacuum unit, and
- Individual well head VOC measurements.

Three VOC discharge analyses are necessary for different reasons. For example, effluent VOC measurements at the discharge stack are necessary to measure and evaluate long-term VOC mass removal rates. By plotting the VOC removal rate at the stack, RMT will be able to monitor the long-term performance and effectiveness of the SVE system. RMT will be able to utilize long-term decreases in observed VOC removal rates as relative indicators of the completion status of the SVE effort. More information regarding this application is discussed later.

Influent VOC measurements taken at the piping manifold inlet to the vacuum unit will be used for comparison with effluent stack discharge measurements. In this manner, RMT will be able to evaluate system effectiveness across the vacuum unit. Inlet VOC concentrations to the

vacuum unit also serve as a baseline of the total VOC being removed from the individual extraction wells.

VOC measurements will also be conducted at individual extraction wells to precisely define the relative VOC removal rates occurring at each of these SVE wells over time. In this manner, "hot-spots" may be better identified. SVE wells exhibiting lower VOC removal rates may also be "throttled" back allowing RMT to more precisely focus the applied vacuum to specific problem areas. The ultimate goal of these various types of discharge analyses is to develop a thorough understanding of the VOC recovery process over time and develop a strong technical basis for justifying termination of recovery efforts, when the appropriate time occurs.

3.2.5 System Performance Analyses

Utilizing the information obtained during the previous steps, RMT will be able to determine if the SVE system is performing in accordance with design expectations. System performance analyses will be conducted weekly during the first month of operation to establish an appropriate bench-mark for system performance. System performance analyses will then back down to a monthly schedule during the first six month of operations, which in turn decreases to a quarterly review after six months. System performance analyses will be used to document the long-term operational history of the SVE system, provide technical justification for system shut-down, and trigger initial system shut-down procedures.

System shut-down procedures will be implemented as follows. In the event that upon completion of a system performance analysis there is sufficient technical justification to warrant shutting down the SVE system, RMT will prepare and submit, for US EPA and SC DHEC review, a formal petition for termination of SVE activities. This petition will contain the necessary technical documentation and applicable arguments for termination of active SVE treatment.

Following US EPA and SC DHEC concurrence, the SVE system will be shut down for a period not to exceed 30 days. During this time, the affected soils will be allowed to reach equilibrium with any residual VOCs that may still be present in the vadose zone. Following completion of the shut-down period, the SVE system will be re-activated and operated for an additional 30-day time-frame, at which time an additional system performance analysis will be performed.

In the event the additional system performance analysis confirms the previous system performance evaluation, RMT will report the results of the system performance evaluation to the US EPA and SC DHEC and advise both parties that confirmation soil analyses are now appropriate to document current VOC levels in the previously affected soils. The specific details of this soil boring program are provided in Section 3.2.8 of this document.

Should the system performance analysis indicate that VOC levels in the subsurface soils have increased appreciably, this will be interpreted as evidence of residual VOC source material and SVE remediation activities will continue until such time as the next system performance analysis suggests otherwise. This process will be repeated until there is substantive evidence to suggest that confirmation soil testing is appropriate.

3.2.6 Sample Location and Frequency

As indicated earlier, operational data will be collected from the vacuum unit, the extraction wells, vacuum monitoring wells, vacuum stack discharge, and at the vacuum unit inlet. Predominantly the operational data will consist of vacuum measurements and physical readings from vacuum gages and equipment instrumentation. Analytical samples will be collected at the SVE wells, the inlet to the vacuum unit, and the effluent discharge from the vacuum unit. The schedule of frequency for these activities is weekly during the first month, monthly through the sixth month, and quarterly for all testing thereafter.

Analytical samples will be collected from the eight SVE wells and the inlet and discharge of the vacuum unit by collecting a known volume of vapor through a charcoal tube and submitting this sample for analysis. A minimum of five liters of soil vapor will be drawn through the charcoal tube using a hand-operated vacuum pump. The sampling port, charcoal tube, and hand pump will be connected by Tygon tubing. All charcoal tubes will be submitted for VOC analysis to a qualified analytical facility.

3.2.7 Reporting Requirements

RMT will provide the US EPA and SC DHEC with summary reports of SVE activities at least on a semi-annual basis. SVE system reports may also be submitted for regulatory review and consideration at more frequent intervals depending on the observed progress of the remediation effort.

3.2.8 Confirmation Soil Sampling Activities

In the event that system performance analysis confirms that VOC removal rates from the SVE wells have decreased to a level that is no longer productive to continue remediation, confirmation soil samples will be collected to assess the levels of VOCs present in the treated vadose zone soil.

For this sampling program, a gridded system of borings will be drilled at the approximate locations shown on Figure 3-1. These grids will encompass Areas 1, 2, and 3 as defined by the US EPA's Record of Decision. This effort will require drilling a maximum of 12 soil borings.

Each soil boring will be drilled to a depth of approximately 45 feet below land surface. Soil samples will be collected at 10 feet, 20 feet, 30 feet, and 40 feet below land surface. Water level measurements collected from nearby monitoring wells will be used to confirm the depth of the water table at the time of sampling. Soil samples collected from these borings will be analyzed to evaluate the horizontal and vertical extent of residual VOCs in the vadose zone soils.

Soil samples will be analyzed for the volatile portion of the Target Compound List (TCL) in accordance with Data Quality Objective (DQO) Level 3 protocols. The analytical results from these efforts will be compared against theoretical calculations for VOC levels in soil that would present no threat of long-term contamination by leaching. Typically, these theoretical calculations have been performed using the Summer's Organic Leaching Modelling or another similar approach.

In the event that residual soil VOC levels can be demonstrated to be below levels for concern, RMT will transmit these findings to the US EPA as evidence that the SVE portion of the Site Remediation has been successfully completed. These data will be presented in the form of a Remedial Action Completion Report. Should the data suggest that further SVE is required, the SVE System will be re-started. Strategic modifications to the SVE system may be called for as a part of the confirmation process. System modifications will be implemented before re-start of the system.

3.3 Ground Water Extraction System Monitoring

Data collected during the RD indicates that there are significant differences in the geologic and hydrologic characteristics on-site. The data further suggests a likelihood that these conditions are controlling the distribution of VOCs on-site. In order to evaluate the ground water extraction system and monitor changes in ground water flow and water quality conditions resulting from ground water withdrawal, additional monitoring locations are proposed to supplement the existing monitoring wells on-site.

3.3.1 Performance Monitoring Well Installation

Three Waterloo multi-level monitoring wells are proposed to supplement the existing on-site monitoring wells. These multi-level wells will be installed at the locations shown on Plate 3-1. These wells will be constructed to isolate three discrete zones within the aquifer (bedrock, transition zone, and saprolite). Sampling intervals will be equipped with dedicated sampling pumps and pressure transducers to facilitate the collection of ground water samples and record changes in water levels within each interval. Further details regarding multi-level monitoring wells are provided in Appendix B.

3.3.2 Sample Location and Frequency

This section presents the field sampling and analytical program for ground water performance standards verification. Data collection activities described in this section are intended to meet the needs of the project by providing data of a sufficient quantity and quality to evaluate the effectiveness of the ground water extraction system in meeting the ROD-stated remedial objectives. The information obtained during this process will also be used to guide subsequent RD/RA activities, as needed.

Performance standards verification for the Medley Farm Site is based on discussion and requirements presented in the Medley Farm Consent Decree, ROD, SOW, meetings with the US EPA, and the results of previous site investigations. The sample locations for the Performance Standards Verification program are shown on Plate 3-1. Sampling methods, chain-of-custody, preservation and equipment procedures are designed to comply with the US EPA Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual (SOPQAM), issued February 1, 1991. Samples collected during this program will be analyzed using Data Quality Objective (DQO) Level III protocols. Until the Medley Farm ground water extraction system is operational, the quarterly monitoring program will be maintained.

SDMS

Unscannable Material Target Sheet

DocID: 4275 Site ID: SCD980558142

Site Name: Medley Farms Park 6 of 13

Nature of Material:

Map: ☒

Computer Disks: ☐

Photos: ☐

CD-ROM: ☐

Blueprints: ☐

Oversized Report: ☐

Slides: ☐

Log Book: ☐

Other (describe): ☐

Amount of material: 1 (Proposed Data Point Location Map)

Please contact the appropriate Records Center to view the material.

Before start-up of the ground water recovery system and at the conclusion of the first year of active ground water remediation, all on-site monitoring wells (including the three intervals within the multi-level wells proposed herein) will be sampled and analyzed for the compounds listed in Table 3-1. Following review of the results from the second site-wide monitoring episode, all monitoring wells in which detectable concentrations of VOCs have not been identified will be deleted from the analytical program. Water level data will continue to be collected from wells deleted from the analytical program on a quarterly basis to facilitate development of water table and potentiometric surface maps.

After the ground water extraction system has been brought on-line, ground water samples will be collected from selected locations on a quarterly basis. Ground water samples will be collected from three monitoring intervals within each of the three multi-level wells (MLW-1, MLW-2, and MLW-3), the site background wells (SW-1, BW-1), and from monitoring wells which have historically yielded VOC concentrations above the site remediation levels (SW-4, BW-2, SW-3, SW-108, BW-108, SW-202, BW-202, and BW-201). These wells will continue to be sampled on a quarterly basis until it can be demonstrated that the concentration of VOCs has fallen below remediation levels and remained below remediation levels for five consecutive quarters or until the quarterly sampling data demonstrates that the concentrations of one or more compounds remain at asymptotic values above the remediation levels for two years. Monitoring wells with detectable levels of VOCs, including those with concentrations below cleanup levels, will be sampled annually and analyzed for the compounds listed in Table 3-1.

In addition, if it can be demonstrated that after implementing measures to maximize the performance of the ground water extraction system (i.e., alternating pumping at wells to eliminate stagnation points; pulse pumping to allow aquifer equilibration and to allow absorbed contaminants to partition into ground water; and installing additional extraction wells to facilitate or accelerate cleanup of the contaminant plume) that concentrations of one or more compounds remain at asymptotic values above the remediation levels or that the remediation goals have been met and maintained for five consecutive quarters, the Medley Farm Site Steering Committee may petition the US EPA to request a determination of technical impracticability and a waiver or modification of the remediation levels. This petition will be prepared in accordance with the requirements outlined in the Scope of Work (SOW).

TABLE 3-1
PROPOSED ANALYTICAL PROGRAM FOR
GROUND WATER EXTRACTION SYSTEM

	QUARTERLY [1]	ANNUAL [2]
Ground Water Monitoring Wells	Multi-level wells, site background wells, wells with concentrations of VOCs above site cleanup levels	All on-site monitoring wells for two rounds. Multi-level wells, site background wells and wells with detectable levels of VOCs.
Analytes	Site-specific VOCs [2]	Volatile portion of TCL
Analytical Method	US EPA SW-846 Method 8010/8020 (GC) modified to include acetone and 2-butanone	US EPA SW-846 Method 8260 (GC-MS)
Quality Control	One duplicate per sampling episode. No matrix spike or matrix spike duplicate. One Field Blank, one Trip Blank per cooler.	One duplicate per sampling episode, one matrix spike and matrix spike duplicate per 20 samples. One Field Blank, one Trip Blank per cooler.

- [1] Based on historical/water quality results, the quarterly sampling program will include wells MLW-1 through MLW-3, SW-1, BW-1, SW-4, BW-2, SW-3, SW-108, BW-108, SW-202, BW-202, and BW-201.
- [2] Compounds identified by EPA as requiring remediation.

Water level measurements will be recorded automatically from the multi-level wells and monitoring wells BW-2, BW-109, and BW-108 using dedicated pressure transducers with programmable data loggers. Water level measurements, including the time the measurement was recorded, will be made hourly for one week after the extraction system has been brought on-line and every twelve hours thereafter. In addition, in conjunction with the quarterly sampling events, water level measurements will be made in the on-site monitoring wells and staff gauges.

3.3.3 Reporting

Project status reports will be submitted to the US EPA quarterly. These reports will provide data collected during the previous quarter and the following:

- Tabulated water table and potentiometric surface elevations,
- Tabulated ground water quality results,

- Tabulated data on volumes of ground water pumped and pumping rates,
- Summary of system downtime and modifications, if any, and
- Discussion of any repairs, maintenance or shutdowns of the system.

At the conclusion of four quarters of results, an annual report will be prepared that includes the following information:

- Tabulated water table and potentiometric surface elevations,
- Hydrographs,
- Tabulated water quality results,
- Time versus concentration graphs,
- Tabulated data on volumes of ground water pumped and pumping rates,
- Summary of system downtime and modifications, if any,
- Discussion of any repairs, maintenance, or shutdowns of the system,
- Maps showing the distribution of VOCs in ground water exceeding site remediation levels,
- Water table and potentiometric surface maps,
- Evaluation of water quality and elevation data discussing the area of influence, capture zones, and boundary conditions,
- Discussion of the system's effectiveness in meeting remedial goals, and
- Proposed modifications/expansion, or technical maximization measures to meet ground water remediation goals, and
- Proposed modifications to the analytical program.

Quarterly project status reports will be submitted 30 days following completion of the preceding quarter. The annual evaluation report will be submitted 45 days following completion of the fourth quarter.

Drilling and well installation activities will be accomplished according to the procedures outlined in Section 5.7 of this PSVFSAP. The location and elevation of the newly installed wells will be determined by a registered surveyor according to the procedures outlined in Section 3.4, that follows.

3.4 Surveying

The proposed monitoring wells and extraction well locations will be surveyed relative to mean sea level (MSL) and the state plane coordinate system. Existing monitoring wells at the site have been surveyed previously by SEC and RMT.

Section 4

SAMPLE DESIGNATION, CONTROL, FIELD RECORDS, AND PHOTOGRAPHS

This section presents procedures for sample control, field records, and photographs. Sample control includes sample identification and chain-of-custody procedures.

4.1 Sample Designation

A sample identification system was previously developed for the Remedial Investigation/Feasibility Study by SEC. Samples were assigned a unique alpha-numeric sample descriptor in accordance with that identification system that identified the sample type, sample site number, and sample interval. For example: RW01 indicated that the sample was collected from river water (RW), and that it was the first sample collected (1). The first two letters specified the media type, followed by the sample numbers, and other descriptive data where appropriate. Sample descriptors did not contain hyphens but instead use a zero to hold the place in single digit numerals for laboratory data entry purposes. The locations of samples, as illustrated on Plate 3-1, contain hyphens and do not use zeros (e.g., RW-1). This is an important distinction to keep in mind when reviewing site data.

In addition to the existing RI/FS sampling locations, RMT has installed a number of monitoring and extraction wells during the RD/RA process. The jet pump ground water extraction wells consist of two loops (System A and System B). Extraction wells located along the A loop have been assigned a letter designation A followed by the well number. Extraction wells located along the B loop have been assigned a letter designation B followed by the number of the well (e.g., A-1, B-4).

Soil vapor extraction and soil vapor monitoring wells have been assigned an alpha-numeric sample descriptor. Soil vapor extraction wells are designated as VE wells and soil vapor monitoring wells are designated VM wells (e.g., VE-101, VM-301).

The proposed Waterloo Multi-level wells have been assigned an alpha-numeric designation that designates the well as a multi-level construction. The prefix MLW denotes that the well is a multi-level well. The MLW is followed by the specific well number (e.g., MLW-1).

Sample identification numbers will be included on both the chain-of-custody forms and sample containers. Duplicate samples will be given unique sample identification numbers which will be noted in

the field book. Sets of containers shipped together will be assigned a chain-of-custody form which will travel with the sample containers. A copy of the chain-of-custody form with its assigned sample numbers will be kept in the laboratory to help identify samples which might become separated from the discrete sample delivery group.

4.2 Chain-of-Custody Procedures

By the use of chain-of-custody procedures, the handling of samples will be traceable from the time of collection to the time of final sample disposition. Field personnel will record the sample number, date and time of sample collection, personnel involved, type of sample, type of analyses to be performed, type of containers filled, volume of sample collected, and preservatives used. *In situ* measurements (e.g., pH, temperature) will be recorded in the sampling team's field notes.

Chain-of-custody forms will accompany sample containers to document the transfer of the containers and samples from the originating laboratory, through the field collection, and to the laboratory receiving the samples for analyses. A sample container is under custody in the field if the following conditions exist:

- It is in the field investigator's actual possession;
- It is in the field investigator's view, after being in his/her physical possession;
- It was in the field investigator's physical possession and then she/he secured it to prevent tampering.

Chain-of-custody procedures are further discussed in Section 5 of the PSVQAPP.

4.3 Field Records

4.3.1 Purpose

This section of the PSVFSAP describes requirements and procedures for documentation of field activities. It is essential that all field documentation provide a clear, unbiased picture of field activities.

4.3.2 Procedure

Bound, serially numbered field notebooks will be used on work assignments requiring field activities. The RMT or Steering Committee's On-Site Coordinator will be responsible for issuing

the field notebooks. A record will be maintained by the On-Site Coordinator documenting the assignment of field notebooks. Entries into field notebooks will be legibly written in waterproof ink and provide a clear record of field activities.

The following information will be provided on the inside front cover or first page of the field notes:

- Project Name,
- Site Location, and
- Job Number.

Instructions for documenting field activities are provided below. These instructions are organized as follows:

- The first set of instructions and procedures described below, entitled "Format", provides general guidance relating to the format and technique in which notebook entries are to be made.
- The second set of instructions provided, entitled "Content", provides guidance on information to be recorded when documenting field activities.

Format

Instructions and procedures relating to the format and technique in which notebook entries are made are as follows:

1. Leave the first two pages blank. They will provide space for a table of contents to be added when the field notes are complete.
2. If photographs are taken as part of the field investigation, a brief photograph description will be made in the notes at the time the photograph is taken. Photograph descriptions will be numbered sequentially in the notes.
3. Entries will be made in waterproof ink.
4. Entries will be made in language which is objective, factual, and free of personal opinions or terminology which might later prove unclear or ambiguous.
5. Entries will be printed as neatly as possible.
6. Entries will be logged using a military-based 24 hour clock (e.g., 1 p.m. = 1300 hours).

7. Errors in the field notes will be indicated by drawing a single line through the text, the text of which will be left legible. Errors addressed in this manner will be initialed and dated.
8. A new page will be started at the beginning of each day's field activities and the remaining clear page at day's end will be filled with a single initialed diagonal line at the day's end.
9. The person taking notes will sign, number and date each page.
10. The On-Site Coordinator will complete a quality control check to verify that the notes are legible and contain an accurate picture of the day's field activities. This review should occur as soon as possible after the notes were taken. Copies of field notes will be made weekly and sent to the project file. The Quality Assurance Reviewer will be responsible for evaluating organization of the field notebook.
11. All subsequent additions, clarifications, or corrections to the field notes must be dated and signed.

Content

Instructions and procedures providing guidance on the information to be recorded concerning field activities are provided below:

1. A new page should be used at the start of each day's activities. Personnel will identify the date, time, job number, location on-site, field personnel, and observed weather conditions. Changes in weather will be noted when they occur.
2. Sketches or maps of the site will be included and used to identify photograph and/or sample locations. Landmarks will be noted, north will be indicated, and if possible, an approximate scale will be included. As many sketches and maps as needed will be included.
3. Field personnel responsible for note taking will log photographs taken in the field in the field notebook. The photograph locations will be referenced to a site sketch or map. Photograph information will include the date, time, location, photographer, sample number, roll number, frame number, and a description or identification of the subject in the photograph.
4. Use of on-site health and safety equipment will be recorded. Observed potential hazards to health and safety will be described. The level of protection and decontamination procedure used will be documented.
5. As part of the chain-of-custody procedure, sampling information will include sample number, date, time, sampling personnel, sample type, designation of sample as a grab or composite, and any preservative used. Sample locations will be referenced to sample numbers on a site sketch or map.

6. When sampling is complete, the field notes will include date, time, sample numbers, and description. The sample identification will also indicate whether the sample was a split or duplicate and the individual/company who received the split or duplicate sample.
7. Information for *in situ* measurements will include a sample ID number, the date, time, and personnel taking measurements. If in-field calculations are necessary, they will be checked in the field by a second team member, whenever possible.
8. Visitors arriving on-site, and relevant discussions will be recorded. The relevant information documented should include name of conversation participants, the name of the firm or group represented (if applicable), address, and phone number. The Project Manager or his designee shall be advised of all person(s) or groups entering the site.
9. All other information deemed relevant by the project team member will be recorded.

The On-Site Coordinator will distribute and track bound and numbered field notebooks. Transfers of field notebooks to other individuals (including subcontractors) who have been designated to perform specific tasks on the project will be recorded. Project notebooks are the property of the Medley Farm Site Steering Committee. No field notes may be destroyed or thrown away, even if they are illegible known to or contain inaccuracies.

4.4 Photographs

As discussed in Section 4.3, photographs taken in the field will be documented in the field notebook. After the film is developed, each slide or print will be labeled with the following information:

- job identification number,
- date,
- location,
- roll number,
- frame number, and
- sample number (if appropriate).

Section 5 SAMPLING EQUIPMENT AND PROCEDURES

Samples are collected to obtain a representative portion of the material or medium being sampled.

Valid results depend on the following:

- Obtaining samples that are as representative as possible of the material or medium being sampled;
- Using proper sampling, sample handling, and preservation techniques;
- Identifying the collected samples and documenting their collection in permanent field records;
- Maintaining sample chain-of-custody procedures; and
- Protecting the collected samples by properly packing and transporting them to a laboratory for analysis.

5.1 General Considerations

The following factors and procedures will be considered and/or implemented in planning and conducting sampling operations. These factors and procedures will be considered in view of the specific objectives and scope of the field investigation, as presented in this PSVFSAP and the PSVQAPP.

- Safety of sampling personnel.
- Selection of representative sampling sites.
- Selection and proper preparation of sampling equipment.
- Selection of parameters to be measured and evaluation of sample fractions to be analyzed (e.g., dissolved, suspended or total fractions for water samples).
- Required sample volumes.
- Selection and proper preparation of sample containers.
- Sample preservation.
- Sample holding times.
- Sample handling and mixing.
- Special precautions for trace constituent sampling.

- Sample identification.
- Procedures for identifying potentially hazardous samples.
- Collection of auxiliary data.
- Transportation and shipping of samples
- Sample chain-of-custody.

5.2 Terminology

Sampling terminology is defined as follows:

- ***Grab Sample***
A grab sample is an individual sample taken from one point in space at essentially one point in time.
- ***Composite Samples***
Timed Composite - A composite sample containing a series of discrete sample aliquots taken at recorded intervals over the compositing period.
- ***Flow Proportional Compositional*** - A sample containing a series of discrete sample aliquots taken proportionally to the flow rate over the compositing period.
- ***Areal Composite*** - A sample composited from individual grab sample aliquots collected over an area or in a cross-section. The grab sample aliquots will be of equal volume and shall be collected in an identical manner.
- ***Split Samples***
A split sample is a sample which has been divided into two or more samples. Adequate mixing will be performed such that the two portions of a split sample are, for all practical purposes, identical. US EPA or its designee may from time to time desire to obtain split samples. US EPA is expected to provide their own containers for collection and shipping of samples. This procedure is appropriate for analysis of semivolatile organic compounds and inorganic constituents. Volatile organic samples need to be collected as discrete, grab samples.

- ***Duplicate Samples***
Duplicate samples are samples collected simultaneously from the same source under identical conditions into separate containers.
- ***Control or Background Samples***
Background or control samples are collected in an area known or thought to be free from the constituents of concern.
- ***Sample Aliquot***
A sample aliquot is a portion of a sample that is representative of the entire sample.
- ***Trip Blank***
A trip blank is a set of sample bottles, filled with organic-free water, that accompanies the empty sample bottles to the field and returns to the laboratory with the collected samples. The trip blank is used as a quality control check for the presence of volatile organics that might contaminate the samples.
- ***Field Blank***
A field blank is a set of sample bottles that are filled with organic-free, deionized water in the field. The organic-free, deionized water is handled in the same manner as the sample. Field blanks contain the same preservatives as the samples.
- ***Rinsate Blank***
A rinsate blank is a sample of organic-free, deionized water that has been passed across the surface of sampling equipment after the equipment has been decontaminated. The rinsate blank is used to check for the effectiveness of the field decontamination procedure between samples. One rinsate blank will be collected at random from each type sampling equipment (weekly) used during the soil sampling program. The rinsate blank sample analysis will be comparable to the analysis being performed on the soil sample.

5.3 Decontamination Procedures

Proper decontamination of sampling equipment is essential to minimize the possibility of cross contamination of samples. Sampling equipment will be decontaminated before sampling and between the collection of each sample, unless samples are to be composited. Sampling equipment will be decontaminated with materials specified in the ESBSOPQAM and according to the following procedures:

Step	Procedure
1.	Clean with tap water and laboratory detergent using a brush, if necessary, to remove particulate matter and surface films.
2.	Rinse thoroughly with tap water.
3.	Rinse thoroughly with deionized water.
4.	Rinse twice with pesticide grade isopropanol.
5.	Rinse thoroughly with organic-free water and allow to air dry.
6.	Wrap with plastic or aluminum foil to minimize the possibility of contamination if equipment is going to be stored or transported.

Larger equipment such as drilling and/or backhoe equipment will be steam cleaned prior to initiating the field investigation. During construction, drilling equipment such as drill augers and bits and sampling equipment such as split barrel samplers and drill rods will be decontaminated according to the procedure described above. Following decontamination, drilling augers, bits, split barrel samplers and rods will be wrapped in plastic or aluminum foil between borings. This includes transport from the decontamination area and temporary storage while awaiting use.

Water used for steam cleaning and drilling will be obtained from site water supply which is tied into the Gaffney Water system.

Since site source materials and highly affected soil have been removed, a contamination reduction zone will not be required. The decontamination of equipment will take place on the decontamination pad. The pad is positioned at the same location used during Phase 1 and 2 of the RI. Personnel and equipment leaving the site must pass through the decontamination pad. Spent decontamination fluids will be contained in steel 55-gallon drums.

The decontamination pad consists of a 10 foot by 30 foot flexible membrane liner of high density polyethylene. The area underlying the liner was graded to drain decontamination fluids away from the equipment and separate the isopropanol rinse from the water rinses. Decontamination fluids from each compartment of the decontamination pad are collected at central locations. At these central points, decontamination fluids are contained in shallow sumps and stored according to procedures described above. The pad will be used throughout the RD/RA.

5.4 Surface Water and Sediment Sampling

5.4.1 Sample Site Selection

Selection of surface water and sediment sampling locations has been based on many factors, including: study objectives, water use, point source discharges, location and nature of tributaries, changes in stream characteristics, types of stream bed, stream depth, turbulence, presence of structures, and accessibility.

Surface water sampling sites on streams will be located in areas of the greatest cross sectional homogeneity. Since mixing is principally governed by turbulence and water velocity, the selection of a site immediately below a ripple area will promote good vertical mixing. These locations are also likely areas for sediment deposition since the greatest deposition occurs where stream velocity decreases. Horizontal (cross channel) mixing occurs in constrictions in the channel, but because of velocity increases, the stream bottom may be scoured. Therefore, a constriction is considered a poor sediment sample location. Typical sediment deposition areas are located inside of river bends, downstream of islands, and downstream of obstructions in the water.

The selection of sampling station locations include, at a minimum, the following considerations:

- time of water travel (not distance),
- marked physical changes in the stream channel,
- upstream and downstream relationships to target tributaries, discharges or investigation sites,
- point-source waste discharge or tributary lateral mixing distance,
- non-point source discharges, and
- flow patterns at the mouths of tributaries and possible mixing with main channel or lake.

Seasonal variations will also be considered since water quality and sediment depositional areas may be strongly influenced by changing flow rates. This is also an important consideration when comparisons with other investigations are anticipated.

5.4.2 Sampling Equipment and Techniques

Equipment and sampling techniques will not cause the integrity of the sample to be compromised and will provide a sample which is representative of the medium being sampled. Samples obtained from shallow flowing surface waters will be collected directly into sample containers. The investigator will stand along the edge of the stream or wade into the water, taking care to disturb bottom sediments as little as possible. The sample will be collected by quickly immersing the sample container with the mouth of the container pointing upstream. The sample will be collected at the mid-depth of the stream, upstream from where the investigator stands. Pre-preserved VOA vials will be collected from the stream surface. Stream samples will be collected at downstream locations first. Sample handling, labeling, records, and chain-of-custody procedures are described in Sections 4 and 6 of this PSVFSAP.

Coring, dredging, or scooping will be used to collect a sediment sample (EPA 600/4-83-040, EPA-600/2-80-018). In each method, precautions must be taken to make the collected sample as representative of the sediment as possible. The methods described below have been included for potential use for the Medley Farm Performance Standards Verification.

Sediment samples from shallow waters will be collected, by hand, using stainless steel scoops (EPA 600/4-83-040; EPA 600/2-80-018). The scoops will be decontaminated between each sample or clean scoops will be used for each sample. The samples will be collected upstream of the sample collector. Pebbles greater than 5-mm in diameter and vegetation will be removed from the sample prior to filling the appropriate containers directly from the sampler. Aliquots will be composited in a decontaminated stainless steel holding vessel if a single scoop does not provide sufficient sediment volume to fill the required sample bottles. Samples for VOC analyses will not be composited. Records, labels, and chain-of-custody are maintained as described in Sections 4 and 6 of this PSVFSAP.

5.4.3 Sampling Equipment QA Procedures

The choice of sampling equipment and techniques will be reviewed to see that the methods

provide representative samples of the media being sampled and that materials and procedures are appropriate for sampling the constituents of interest. Equipment will be inspected, tested, and, if necessary, repaired before being issued for each field investigation.

5.5 Ground Water Sampling

5.5.1 Sampling Equipment and Techniques

Four additional monitoring locations are proposed for performance monitoring. Monitoring wells installed during the RI will be equipped with dedicated bottom-loading, closed top, Teflon® bailers. These dedicated bailers will be stored in the wells between sampling events, and will be suspended above the static water level. Dedicated bailers will be decontaminated in the field prior to their use, in accordance with Section 5.3. New nylon cord will be used to extend the bailer to the water surface during each sampling event. The Waterloo multi-level wells will be equipped with dedicated sampling pumps.

The jet pump wells installed as a part of the Remedial Action will be utilized for ground water extraction only. These wells will not be used for collection of environmental samples.

Wells will be purged before a sample is collected. Purge water will be contained in 55-gallon drums while the appropriate volume is being removed from the well. Purge water will then be treated on-site using the procedures outlined in Project Change Notice MF-004, "Aeration of Well Development and Purge Water".

Dedicated bailers or pumps equipped with Teflon® tubing, will be used to purge the monitoring wells. Pumps will be either peristaltic, with a vacuum jug assembly, or submersible sample pumps. A bucket of known volume will be used to measure the volume of water removed during purging. Before the wells are purged, clean, new plastic drop cloths will be spread around the wells to prevent the pumps and the ropes and hoses attached to the pumps from coming into contact with the ground surface.

Purging procedures for monitoring wells will include the following:

Step	Procedure
1.	Measure depth to water and to the bottom of the well.
2.	Calculate volume of standing water and purge at least 3 well volumes, or until the well is dry. The volume of standing water will be calculated by multiplying the volume of one-foot of well casing by the length of the column of water in the well. The volume of one-foot length of 2-inch ID casing is 0.16 gallons. For other well diameters sampled, the volume of one foot length of casing will be calculated by the formula: gallons per foot of casing = $3.14 r^2$ (feet) x 7.481 gallons where r = inside radius of the well casing in feet.
3.	Bail or pump required volume. Water will be removed from the top of the water column during purging.
4.	Measure pH, temperature, and specific electrical conductance (SEC) after each well volume is removed. Purging will be considered complete when the change in SEC between two successive well volumes is less than 10 percent or when the well has been bailed dry.
5.	Note color or turbidity changes during purging.

Ground water samples will be collected as soon as water volumes sufficient to fill the required sample bottles have flowed into the well casing.

Ground water samples for analyses other than volatile organics will be withdrawn from the well using either a Teflon® bailer, the peristaltic pump with a vacuum jug assembly or submersible sample pump and Teflon® tubing. Samples for volatiles analyses will be collected using either a dedicated bailer or a submersible sample pump in order to minimize volatilization of constituents during sampling. In all cases, the VOA sample will be collected first.

Sections 4 and 6 of this PSVFSAP describe the quality control details of sample collection container selection, labeling, and chain-of-custody. Preservation is specific to the types of analyses and the specific requirements are summarized in the QAPP.

A portion of the sample is reserved for the measurement of specific electrical conductance, temperature, and pH in the field. Section 8 of this PSVFSAP covers equipment maintenance, calibration, and measurement procedures for these parameters. These measurements, as well as a listing of containers to be filled, physical description of samples, volumes of water purged,

purging and sampling times and disposition of samples, will be recorded in the field notebooks.

5.5.2 Sampling QA Procedures

Ground water sampling procedures are designed to provide a representative sample of ground water for chemical analysis. Specific procedures for collecting ground water samples to monitor water quality are outlined below and are based on established and accepted procedures.

These methods have been developed over several years and US EPA-approved procedures are used wherever applicable. Proper sampling techniques are necessary to provide representative samples that have not been altered or contaminated by the sampling procedure.

The procedures required to obtain quality samples are arranged in the order in which they are performed. The equipment and methods will vary depending on the type of wells, depth, and laboratory testing program. The QA Reviewer-Hydrogeology is responsible for reviewing procedures used in ground water sampling.

Water Level and Well Depth Measurements

Water level measurements are used to determine the hydrostatic level in monitoring wells. The depth of well measurement is used to calculate the volume of standing water in the well and to determine if the well is obstructed. These measurements will be performed before any water is removed.

An electric water level indicator will be used for water level measurements. A description of this method and other contingent water level measuring techniques is presented in Section 9.4. Total depths of wells are measured by lowering the measuring device to the bottom of the well.

Procedures for cleaning water level measuring equipment are as follows:

Step	Procedure
1.	Wash with laboratory detergent and tap water.
2.	Rinse with tap water.
3.	Rinse with deionized water.
4.	Rinse twice with pesticide grade isopropanol.
5.	Rinse thoroughly with organic-free water and allow to air dry.
6.	Equipment should be placed in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit.

Field Notes

The persons who collect water samples are also responsible for taking field notes. These notes include data on the depth to water, total depth of the well, color, turbidity, time of sampling, pH, conductivity, and other pertinent data. A summary of these notes is used in the data interpretation and analysis of the laboratory results.

Field Measurements of pH, Conductivity and Temperature

The pH, conductivity, and temperature of water samples are measured in the field. The meters used in measurement will be calibrated in the field to the equipment manufacturer's specifications. Calibration procedures are described in Section 8.

Field Sampling Quality Control

Several steps are taken in the field to provide sample quality control. Some of these include the following:

- Cleaning the water level tape between wells.
- Using a dedicated bailer for sampling each well.
- Using a dropcloth at the well to protect the equipment from contact with soil around the well.
- Preparing a field blank sample consisting of organic free water which has been subjected to the same field methods as the samples.

- Field calibration of meters used for pH and conductivity.
- Replicate measurements (4) of pH and conductivity.

5.6 Multilevel Well Installation

5.6.1 Sample Site Selection

Monitoring wells are drilled and installed to provide hydrogeologic and ground water quality data. In selecting ground water sampling sites, the relationship of the following factors to potential sources should be considered and evaluated: direction of ground water flow, depth to water table, thickness of aquifer, stratigraphy, drainage patterns, topography, land use, nearby ground water withdrawals, and surface features such as rock outcrops, seeps, springs, streams, rivers, and wet areas. Proposed well locations are shown in the Medley Farm Site Base Map, Plate 3-1. When appropriate, historical data from existing wells will be used to facilitate location of the monitoring wells.

5.6.2 Well Installation

Borings - The primary choice of drilling methods for monitoring and construction well installation is air rotary and diamond core drilling. As an alternative to air rotary drilling in bedrock, borings in bedrock may be advanced by core drillings. Core barrels will be five and/or ten feet in length and will be NQ or HQ in diameter in accordance with ASTM Method D 2113-83.

Soil and/or Rock Sampling - Soil, and rock cutting samples will at a minimum be collected at 5-foot intervals for lithologic description. If diamond core drilling is used, rock cores will be collected continuously. The samples will be used to develop a geologic log for the boring and to decide on the exact depth of well installation.

When drilling using air rotary methods, drill cuttings will be collected at 5 foot intervals, or at every change in lithology. The compressed air used for drilling will be filtered to remove organics and particulates. Water will be injected with the compressed air to control dust and to cool the tools.

The mud rotary drilling method may be used to install monitoring wells if downhole conditions inhibit proper installation of the well using hollow stem augers. The drilling fluid will consist of

pure bentonite and potable water. Well installations requiring mud rotary will use only enough mud as required to maintain an open borehole. Split barrel samples will be collected at five-foot intervals. Wells will be developed to remove the mud from around the screen. Drilling fluids will be collected in small depressions and allowed to infiltrate into the subsurface. If the air rotary drilling method is used, a small pit will be excavated to collect drilling fluids. These fluids will then be placed in open-top 55 gallon drums.

Samples collected for lithologic description will be logged by a geologist, geotechnical engineer or technician, and stored in clean, moisture-tight jars (minimum 8 oz. volume) or in sample bags as appropriate. Two jars or bags of soil will be collected whenever possible. Cores, if collected, will be labeled and stored in core boxes. Recordkeeping and labeling are described in Sections 4 and 6 of this manual.

Performance Monitoring Well Installation - The design and depth of placement of performance monitoring wells must be designated to meet the specific objectives of performance monitoring and be compatible with the hydrogeologic setting. Unless otherwise stated, monitoring wells installed for performance monitoring of the ground water extraction system will be constructed of a two-inch I.D PVC casing string, stainless steel sampling ports and Teflon sample tubing. There will be no glue(s) used in the construction of the wells. Monitoring wells will be constructed to isolate four separate zones in a single borehole (bedrock, lower transition zone, upper transition zone, and saprolite). If the water table surface is encountered in the upper transition zone, the saprolite monitoring interval will be omitted. Monitoring well casing and screen materials will be steam cleaned prior to installation. During transport from the decontamination area to well site, the materials will be wrapped in plastic and will remain wrapped until ready for installation.

Sampling intervals will be approximately ten feet in length. The screen will be made of a 75 micron stainless steel mesh. Since the packer assembly will not seal against the saprolite, the annular space around the uppermost well screen will be packed with clean quartz sand. Grain size distribution is shown on Table 5-1. The sand pack will be emplaced by tremie and extend approximately two feet above the top of the screen. The top of the sand pack will be sealed via the gravity method (dropped down annular space) with bentonite pellets. Minimum thickness of the bentonite seal will be approximately two feet. Bentonite pellets will be allowed

TABLE 5-1
GRAIN SIZE ANALYSIS OF SAND FOR PACKING WELL SCREENS

US Mesh	Grams Retained	Percent Retained Cumulative	Percent Retained Per Sieve
6	0.00	0.00	0.00
8	0.00	0.00	0.00
10	0.00	0.00	0.00
12	0.00	0.00	0.00
14	0.00	0.00	0.00
16	0.40	0.72	0.72
18	5.90	6.98	6.26
20	15.40	25.97	16.99
25	27.10	48.48	24.51
30	42.30	75.67	27.19
35	52.90	94.63	18.96
40	55.20	98.75	4.11
45	55.60	99.46	0.72
50	55.70	99.64	0.18
70	55.80	99.82	0.18
PAN	55.90	100.0	0.18

Effective Size: 0.524 mm
Uniformity Coefficient: 1.446
sand

to hydrate for eight hours prior to addition of grout. The remaining annular space will then be grouted from the bentonite seal to approximately two feet below the land surface, from the bottom up using a cement bentonite grout slurry placed with a tremie pipe. The ratio of water:cement:bentonite will be approximately 3:6:1. A three-foot by three-foot by six-inch concrete pad will be framed and poured around each well. The concrete pad will extend six inches below the land surface within six inches of the borehole. A steel protective cover will be placed over each well and secured in grout column and/or concrete. Weep holes will be drilled through the protective cover above the concrete pad. Each well will be lockable. The Waterloo multi-level ground water monitoring system is outlined in Appendix A.

Ground water and soil vapor extraction wells - The design basis for the ground water and soil vapor extraction wells is described in the Medley Farm Prefinal/Final Design Report dated May 1993. Drilling, sampling, and construction details are provided in Section 3 of that report.

Documentation of well installation is not dependent on the well design. Field notes will record: the materials used in construction; length of well screen and casing installed; depth of surface casing if used; depth of borehole; diameter of borehole; depth to the bottom of the well; height of well casing above ground; depth, type, and thickness of sand pack, seals and backfill materials; methods used to place seals and backfill materials; depth to water table; and any other factors or problems associated with monitoring well installation.

Performance monitoring wells and ground water extraction wells will be developed using a submersible pump or bailing (PVC bailer) until discharge is sediment-free, or the change in specific conductance and temperature between two successive well volumes is less than 10 percent. Specific pumping rates will depend on well yield. Wells that are pumped dry during development will be allowed to fully recharge and will be pumped again. Ground water removed during well drilling and development will be collected in 55-gallon drums near the drilling location and treated on-site according to the procedures outlines in the Medley Farm Project Change Notice MF-004, "Aeration of Well Development and Purge Water".

Well abandonment, if required, will be accomplished in accordance with the abandonment procedures described in the State of South Carolina Well Standards and Regulations, R.61-71.

Section 6

SAMPLE HANDLING AND ANALYSIS

This section presents general sample handling and analysis methods. Additional information is contained in the PSVQAPP.

6.1 Sample Containers and Shipping

Sample containers, preservation methods and holding times that meet EPA standards will be used. New containers will be used. Water samples for volatile organic analyses will be acidified prior to sample collection. Samples will be checked for pH in the field and when they arrive in the laboratory. Additional preservatives will be added if the pH requirements for preservation are not met. These procedures will be documented on the chain-of-custody form for the samples.

Sample container requirements of solid and liquid samples intended for chemical analyses are summarized in the PSVQAPP. Samples collected from different media that are intended for organic analyses will be collected in the appropriate container. The sample container will be filled completely to minimize air space. Soil samples intended only for physical testing (e.g. grain size) will be placed in clean glass jars (minimum 8 oz. volume). Two jars will be filled from each sample whenever sufficient sample volumes are available.

For delivery of samples to the laboratory, the following procedure will be implemented:

Step	Procedure
1.	Collect, preserve and seal the samples as outlined in this PSVFSAP.
2.	Place sample containers in laboratory shipping container(s). Samples will be sealed inside ziplock containers and double-wrapped with bubble wrap to protect the containers from accidental breakage during shipment and so that the samples do not leak or spill.
3.	If samples must be chilled, either blue ice or watertight bags supplied by the lab will be filled with enough ice to last the trip. In cases where natural ice is used, RMT will place the sealed bags on the sample bottles. This step will prevent leakage of the ice as it thaws.

Step	Procedure
4.	Complete the chain-of-custody forms as described in Section 4.2 of the FSAP.
5.	Tape chain-of-custody form to the inside of the shipping container lid.
6.	Seal shipping container.
7.	Deliver or ship to the laboratory. Fastest available shipping methods will be used whenever required by short holding times or project schedules.

Responsibility for proper use of containers and preservatives is the duty of the On-Site Coordinator and the Project Laboratory Coordinator.

6.2 Selection of Parameters

The list of parameters has been provided in Section 3 of this PSVFSAP. The number and locations of samples are also specified in Section 3 of the PSVFSAP.

6.3 Analytical Procedures

The selection of analytical procedures will reflect US EPA-approved methodology as stated in the PSVQAPP.

Section 7 FLOW MEASUREMENT

The measurement of surface water flow may be necessary during the RD/RA process. Measurement of water flow should be given as much attention and care as collection of samples and their subsequent laboratory analysis. Specific flow measurement techniques are presented in the following portions of this section.

- **Bucket and Stop Watch** - The bucket and stop watch technique is particularly effective for the measurement of small flows. The equipment required to make this measurement is a calibrated container (bucket, drum, tank, etc.), a stop watch, and a wier. Three consecutive measurements should be made, and the results should be averaged.
- **Velocity-Area Method** - This method is based on the concept that the flow in a channel is equal to the average velocity times the cross-sectional area of the channel. The velocity of the water is determined with a current meter; the area of the channel is calculated by using an approximation technique in conjunction with a series of velocity measurements. The United States Geological Survey (USGS) mid-section method and the stream gaging techniques described in the publication, "Discharge Measurements at Gaging Stations" (USGS, 1965) will be the standard practice. Meters will be examined before and after each discharge measurement. The examination will include the meter cups or vanes, pivot and bearing, and shaft for damage, wear or faulty alignment. Meter balance and alignment will be checked prior to each use in the field (9). Meters will be cleaned and oiled daily when in use. Surfaces that will be cleaned and oiled on a yearly basis are the pivot bearing, pentagear teeth and shaft, cylindrical shaft bearing, and thrust bearing at the cap.

Section 8 FIELD ANALYTICAL TECHNIQUES

With any field analytical measurement, the equipment used must be suitable for the analytical method to be made and properly calibrated. In addition to being accurate, field analysis must be conducted on a sample representative of the source from which it was collected. Therefore, the type of sample and location of the sampling site are critical. A detailed discussion of sample type and sample site selection is given in Section 3 of this PSVFSAP.

Specific field analytical techniques to be utilized are presented in this section and the QA procedures for each analytical technique and field test are presented in Appendix A. Field analyses described below will be performed on all water samples collected.

8.1 Measurement of pH

pH measurements will be made electrometrically using a glass combination electrode and portable pH meter. Portable Orion Research Ionanalyzer Model 399 meters with provisions for temperature compensation will be used. Combination electrodes will be used in conjunction with the meters. The pH calibration and measurement procedures are as follows:

- Turn function switch to pH position.
- Select two buffers, the first with a pH of 7. Select a second buffer so that the two buffers bracket the anticipated sample pH.
- Place combination electrode in pH 7 buffer solution.
- Turn the calibration control until the needle points to the pH value of the buffer.
- Remove electrodes from the pH 7 solution. Rinse with distilled water and place in the second buffer solution.
- Turn the temperature compensator knob until the meter needle points to the pH value of the second buffer solution.
- Turn the slope indicator until the arrow of the temperature compensator points to the temperature of the solution. The percent of theoretical slope can be read on the slope scale. A slope of less than 90 percent may be caused by a defective pH electrode or a contaminated buffer solution.
- Remove electrodes from the second buffer solution, rinse with distilled water, and place in unknown solution. Read the pH value of the unknown on the pH scale.

The meter will be checked for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes before mobilizing for field activities.. The meter and electrode will also be calibrated against standard buffer solutions of known pH values (e.g., pH-4, pH-7, and pH-10). While in the field, the meter will be calibrated several times per day with the buffers. In case of an apparent discrepancy in a pH measurement, the electrode will be checked with pH 7.0 buffer and recalibrated to the closest reference buffer. Then the sample will be reanalyzed. Duplicate analyses will agree within 0.2 pH units. The buffer solution containers will be refilled each day from fresh stock solution.

A log book will be maintained and will contain the property number of each pH meter. Calibrations and repairs will be noted in the log book indicating the date, repairs made, person making repairs, calibration records, and time used in the field for each meter. The pH will be reported to the nearest 0.1 pH unit.

8.2 Measurement of Conductivity

A YSI Model 33 set meter will be used to measure specific conductance. Each meter will be checked before mobilizing for field work. Batteries will be checked, and conductivity cells will be cleaned and checked against known standards. Procedures for checking calibration and making field measurements are as follows:

- With the instrument turned off, adjust scale to zero by turning the bakelite screw on the face of the meter so that the needle coincides with zero on the conductivity scale.
- Calibrate the meter by turning the mode control to red line and adjusting the red line control so the meter needle lines up with the red line on the meter face.
- Plug the probe into the probe jack.
- Put probe in solution to be measured.
- Switch mode control to the X100 scale. If reading is below 50 on 0-500 range, switch to the X10 scale. If the reading is still below 50, switch to the X1 scale. Read the meter scale and multiply the reading appropriately. The meter output is expressed in umhos/cm.

Specific conductance will be corrected to 25°C by using the formula:

$$SC\ 25^{\circ}C = SCF [1 + (25^{\circ} - TF)0.02]$$

where SC 25°C = Specific conductance at 25°C

SCF = Specific conductance recorded in field

TF = Temperature recorded in field in degrees celsius.

Duplicate field analyses should agree within ± 15 percent.

A log book will be maintained with all specific conductance meter property numbers. All repairs, calibrations and field time usage will be noted. The log book will include dates, repairs made and person making repair.

Results will be expressed in micromhos/centimeter (umhos/cm) corrected to 25°C. Results will be reported to the nearest ten units. Field book entries will also specify the meter reading at sample temperature.

8.3 Measurement of Temperature

Thermometers will be initially calibrated against a National Bureau of Standards (NBS) certified thermometer. Thermometers will be inspected before each field trip to see that it is not cracked and that there are no air spaces or bubbles in the mercury. If a dial thermometer is used, it will be checked to be sure that it does not have a broken face cover or otherwise show damage. A cross-check with a calibrated NBS certified thermometer will be made semi-annually. Before using a thermometer in the field, field personnel will make a visual observation to see that it has not been damaged. Cross-checks and duplicate field analysis will agree to within $\pm 0.5^\circ\text{C}$.

A log book will be maintained with each thermometer property number recorded. Calibration information, individuals making the calibrations, and dates will be recorded. Field calibrations will be noted in the field notebooks indicating the temperature readings observed. All data will be reported to the nearest 1°C .

Section 9

FIELD PHYSICAL MEASUREMENTS

Field measurements of topographic features, water levels, and physical measurements are frequently required on field investigations. The scope of such measurements depends upon the purpose of the particular investigation.

Physical measurements should be traceable to the actual person making the measurement and to the actual piece of field equipment used to make that measurement. Equipment maintenance and calibration records will be kept in log books and field records, making all such procedures traceable. Time records will be kept using local time in the 2400 hour military format, recorded to the nearest five minutes.

Sampling locations (surface water, sediments, borings, wells, surface soil, etc.) utilized during the field investigations will be surveyed and depicted on a scaled drawing, topographic or other standard map, or be referenced in such a manner that their location(s) are firmly established. The topographic base map for the Medley Farm site was compiled from an April 7, 1988 aerial survey conducted by Bell Mapping Company of Winston-Salem, North Carolina. Surveying will be conducted according to procedures described below and in McCormac (1976).

9.1 Site Mapping

Accurate, complete, and informative field notes in surveying is a primary objective in site mapping. The quality of the final output is a reflection of the field record. The field notes are the only reliable record of measurements made and information gathered in the field. Information gathered will be recorded in the field on bound field notebooks. Notes will be permanent, legible, and complete.

Field notes will be recorded in the field with a waterproof ink pen. Records will not be made on scratch paper and copied later, or based on other information recorded from memory. Also, mistakes in field notes will be crossed out, initialed, and dated. Notes recorded during site mapping will follow the guidelines presented in Section 4.3.

The field notes will accomplish the following:

- Provide adequate and complete information which can be understood by someone other than the note-taker.
- Provide professional documentation of work done or data gathered.

The surveyor is encouraged to use notebook space liberally in recording necessary data. Explanatory remarks are encouraged to clarify the field procedures and provide added details. Field sketches are also very useful and should be used freely. Two important aspects of each survey to be addressed in the field notes include:

- **Starting and Ending Basis of the Survey** - The surveyor will explain and document the starting and ending points of his survey. This applies to both the horizontal and vertical controls. This will require a paragraph of explanation and sketches and/or cross references to data in notes of previous surveys.
- **Clear Indication of Final Results and Checking Procedures** - The final results and checks will be plainly indicated. Erasures shall not be used as they raise uncertainties about the reliability of the data. Alterations, additions, revisions, reductions, or comments added to field notes should be written in colored ink or pencil (usually red) to indicate that such information is not part of the original field record. The person making such notations will initial and date each page so affected.

A checklist of information to include in the field notes follows:

- Date.
- Names of crew members.
- Condition of weather, observed temperatures, relative wind speed, and barometric pressure if an EDM is to be used.
- Equipment used, listing the serial number or other identification.
- Location of survey by section description or other legal parcel identification.
- Project and element number.
- North arrow.
- Description of all monuments found.

- Measurements as made (slope distance and vertical angles, temperature, taping, horizontal angles, etc.)
- Corrected distances and angles.
- Description of monuments set.
- Relation of possession or encroachments to survey lines.
- Outline or sketch of major traverse or property boundary.

9.2 Ground Elevation Surveys (Vertical Control)

The elevation of the measuring point of wells and a reference point on staff gages will be surveyed to allow correlation of water levels. Additionally, ground elevations may be required for topographic purposes. Standard engineering leveling techniques, as described in basic surveying textbooks, establish the methodology for providing vertical control. The datum referenced for elevation control is the National Geodetic Vertical Datum (NGVD), informally known as 1929 sea level datum, established by the U.S. Coast and Geodetic Survey. Bench marks of known elevation should be used. If no bench mark is located in the vicinity of a site investigation, an arbitrary temporary bench mark should be established on a permanent location (i.e., bridge wingwall, foundation, or corner post). The location of bench marks utilized shall be shown on the site sketch map. Elevation surveys will be conducted to form a circuit; for example, the survey line should close back to a bench mark. Third order accuracy should be obtained on level circuits; for example, on a one-mile circuit, the closure should be within 0.05 foot. Length of sight will not ordinarily exceed 250 feet, with turning point back shots and fore shots deviating no more than 50 feet from one another.

9.3 Surface Water Stage

Surface water stage will be measured on standard staff gages graduated to 0.01 foot. The staff gage will be firmly anchored in the bed of the river, stream, or lake. Staff gages will be surveyed and referenced to NGVD. Measurements of water stage will be noted in field logs along with date, time, and site location. Water stage will be recorded to the nearest 0.01 foot.

9.4 Ground Water Level Measurement

The measurement of ground water level in wells is typically conducted in conjunction with ground water sampling. Data from such measurements is needed to establish ground water gradients, and ultimately, the direction of ground water flow.

Ground water level measurements are made in reference to an established reference point on the well casing. This reference point will be documented in field records. Reference points will be tied in with the NGVD (Mean Sea Level, MSL) or a local datum. Local datum could be used for an isolated group of wells that will not be combined in analyses of regional hydrogeology. Ground water level measurements will be made and recorded to the nearest 0.01 foot. The calculated elevations will be reported to the nearest 0.01 foot. The water level indicator will be decontaminated between wells by rinsing with deionized water, twice rinsing with propanol, rinsing with deionized water, and air drying.

9.4.1 Specific Ground Water Level Measuring Techniques

Measuring the depth to the ground water table can be accomplished by the following methods:

- **Electric Water Level Indicators** - This method consists of a spool of small diameter insulated steel cable with a probe attached to the end. When the probe comes in contact with the water, the circuit is closed and a meter, light, and/or buzzer attached to the spool signals the contact. Penlight batteries are normally used for a power source. Depth to water is read from permanent marks on the cable to which the probe is attached. Depth is recorded to the nearest 0.01 foot by measuring the distance between the nearest permanent foot mark and the point where the meter indicated the water level.
- **Chalked Tape** - The end of a weighted tape will be chalked and lowered into the well while recording the amount of tape lowered. The tape will be retrieved from the well and the wet chalked area will be subtracted from the total measurement.
- **Popper or Bell Sounder** - A bell or cup shaped weight that is concave on the bottom will be attached to a measuring tape and lowered into the well. A "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading will be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight barely strikes the water.
- **Weighted Tape** - This method is the same as the "bell sounder" except that a steel weight is fastened to the end of the tape measure.
- **Other Methods** - Other types of water level indicators and recorders are available on the market such as the sliding float method, air line pressure method, and electrical and automatic recording methods. These methods are primarily used for closed systems or permanent monitoring wells.

9.4.2 Specific Quality Control Procedures

Ground water level measuring devices will be calibrated to 0.01 foot accuracy once yearly.

Before use, these devices are prepared according to the manufacturer's instructions (if appropriate) and checked for obvious damage.

Section 10

HEALTH AND SAFETY MONITORING

Health and safety monitoring will be carried out as described in the site specific Health and Safety Plan in compliance with OSHA Occupational Safety and Health Standards 29 CFR Part 1910. This Plan includes, but is not limited to:

- site characterization and analysis,
- site control,
- training,
- medical surveillance,
- engineering controls,
- monitoring,
- material handling programs,
- decontamination procedures, and
- emergency response procedures.

This health and safety program is presented in the RMT Health and Safety Policy. In accordance with this program and OSHA 29 CFR 1910.120, the Medley Farm project site had a site-specific, detailed Health and Safety Plan prepared. Specific requirements for activities on the Medley Farm site are outlined in the Health and Safety Plan.

10.1 Organic Vapor Monitoring

Organic vapor monitoring will be conducted with portable direct reading field equipment. If necessary, air samples will be collected in adsorbent tubes for laboratory analyses to determine the composition

and concentration of vapors and gases. Procedures for collecting air sampling data are outlined in the following narrative.

Century Systems Portable Organic Vapor Analyzer Model OVA-128 (OVA)

- Follow start-up procedures and calibrate unit (operator manuals will be kept with the instrument). The unit startup and calibration procedures are outlined in Appendix A.
- Conduct survey with instrument in survey mode at areas of potential concern.
- Periodically monitor meter to identify any increase in concentration of organic vapor.
- Consult Site Health and Safety Plan for response to organic vapor concentrations detected above background levels.
- Use laboratory grade hydrogen gas to refill the unit as necessary.
- Malfunctions detected with this piece of equipment should be reported to the On-Site Coordinator who will take appropriate action to correct the situation.

HNu Systems, Inc. Model P1 101 portable Photoionization Analyzer with 10.8 EV probe.

- Follow start-up procedures and calibrate unit according to instructions included in Appendix A.
- Conduct site survey in areas of concern.
- Consult Health and Safety Plan for guidance on response to organic vapor levels detected above background.
- Periodically monitor meter to identify any increase in concentration of organic vapors.
- Malfunctions detected with this piece of equipment should be reported to the On-Site Coordinator, who will take action to correct the situation.

Sampling activities or activities being conducted in areas that are suspected to contain hazardous substances require regular air monitoring to indicate if the site activities are causing excessive concentrations of airborne constituents. The background concentration of organic vapors will be determined in an area free of influences from organic vapor sources. The OVA or HNu instrument will be used to measure organic vapor concentrations where the sampling activities are being conducted. The instrument will sample air at the breathing zone level (3 to 6 feet above ground level) at the sampling location. The immediate area will be evacuated and personal protection levels will be evaluated if organic vapor concentrations attain or exceed action levels established in the site specific Health and Safety Plan. Additional air sampling may be required to characterize the types and

concentrations of air constituents responsible for the OVA/HNu readings if the source of contamination and the substances likely to be present cannot be readily and reliably identified. The On-Site Coordinator will be responsible for:

- Set up and calibration of the unit.
- Periodic observation of the unit to take readings and ensure that it is functioning properly.

Air monitoring data will be turned over to the site Health and Safety Officer at the end of each day. If a strip chart recorder is used, the strip chart for each monitoring station will be labeled with the location, time, date, type of activity monitored and instrument operator's name.

10.2 Explosimeter

When either OVA or HNu readings exceed 50 ppm, an explosimeter will be used to determine the percent LEL (lower explosive limit) of combustible gases and vapors. The procedures to be followed include:

- Set up and calibrate units according to procedures described in Appendix A.
- Refer to Health and Safety Plan if levels above background are detected.
- Malfunctions detected with this piece of equipment should be reported to the On-Site Coordinator who will take action to correct the situation.

Section 11

DATA REDUCTION, VALIDATION, AND REPORTING

This section establishes the procedure for data reduction, validation, and reporting for field and laboratory measurements. Established techniques will be employed for data reduction and validation. The method used for data reduction and validation will be documented for each technique. Where possible, written procedures or instructions will accompany the data or be specifically cited. The Quality Assurance Reviewers will be responsible for determining that data reduction, validation, and reporting methods follow the approved procedures. The reviewers will see that corrective actions are implemented, as needed.

11.1 Water Level Measurements

Water level measurements made during the course of the project will be transferred from the field notebooks to a summary sheet. Water level elevation will be determined by subtracting the depth to water from the surveyed elevation of the well head reference point. Water levels will be measured within a period of 36 hours to allow correlation. The Field Technician will validate each round of water level measurements by comparing it to previous data and to water level values from surrounding monitoring wells that are completed in the same hydrostratigraphic unit. If there are substantial changes, the water level measurement will be repeated. If the data cannot be remeasured, the On-Site Coordinator is responsible for determining if an error was made in recording the depth to water, or in surveying the elevation of the reference point of the top of the well. If necessary, monitoring wells with a consistent history of questionable water levels will be re-surveyed.

11.2 Industrial Hygiene

The Site Safety Officer or his designee will be responsible for recording and reducing the air monitoring data. Data will be validated by the Site Safety Officer in a timely manner to minimize the risk to the health and safety of on-site workers. Action required in response to the data will be coordinated with the Health and Safety Director and the Project Manager. The Quality Assurance Reviewer-Health and Safety will provide Quality Assurance surveillance of the Site Health and Safety Plan.

Air monitoring instruments will be used on-site to document the air quality and form the basis for changing the level of protection required by on-site staff. The data will be incorporated in the project files and summarized in progress reports by the Site Safety Officer.

11.3 Laboratory

Analytical data produced during site investigation will be reduced, validated, and reported using the procedures found in the PSVQAPP.

Section 12
REFERENCES

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2. Scaff, et al. 1981. Manual of Ground Water Sampling Procedures. National Water Well Assoc., Columbus, OH.
3. USEPA, 1980. Samples and Sampling Procedures for Hazardous Waste Streams, United States Environmental Protection Agency, Municipal Environmental Research Laboratory, EPA-600/2-80-018.
4. USEPA, 1983. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods. EPA 600/4-83-040. Environ. Moni. Sys. Lab., Las Vegas, NV.
5. USGS, 1965. "Discharge Measurements at Gaging Stations," Hydraulic Measurement and Computation, Book I, Chapter 11, United States Department of Interior, Geological Survey.
6. Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, U.S. EPA Region IV, Environmental Services Division, February 1, 1991.
7. Workman, 1984(A). Workman, 1984(B).

APPENDIX A
VACUUM UNIT PERFORMANCE FORMS

DAILY CHECK OF GROUND WATER REMEDIATION SYSTEM

Date ____/____/____

#	CHECK POINT	GAGE READING	COMMENTS	INITIALS
1	Is there any erosion at Jones Creek?			
2	Are the diffuser and all related equipment functioning properly?			
3	Flow reading on the discharge pipe			
4	Pressure in the sump tank of the air stripper			
5	Is there any erosion on the grade between the air stripper and the creek?			
6	Pressure reading on System A's centrifugal pump and check for any visible irregularities			
7	Pressure reading on System B's centrifugal pump and check for any visible irregularities			
8	a) Pressure into Well 101 (found in well vault)			
	b) Flow into Well 101 (101A)			
	c) Flow out Well 101 (101B)			
9	a) Pressure into Well 102 (found in well vault)			
	b) Flow into Well 102 (102A)			
	c) Flow out Well 102 (102B)			
10	a) Pressure into Well 103 (found in well vault)			
	b) Flow into Well 103 (103A)			
	c) Flow out Well 103 (103B)			
11	a) Pressure into Well 104 (found in well vault)			
	b) Flow into Well 104 (104A)			
	c) Flow out Well 104 (104B)			

- * Check all readings with the previous day's and note any differences and reason for that difference.
- ** For any equipment needing repair, indicate action taken to initiate these repairs.

DAILY CHECK OF GROUND WATER REMEDIATION SYSTEM (Page 2)

Date ____/____/____

#	CHECK POINT	GAGE READING	COMMENTS	INITIALS
12	a) Pressure into Well 105 (found in well vault)			
	b) Flow into Well 105 (105A)			
	c) Flow out Well 105 (105B)			
13	a) Pressure into Well 106 (found in well vault)			
	b) Flow into Well 106 (106A)			
	c) Flow out Well 106 (106B)			
14	a) Pressure into Well 107 (found in well vault)			
	b) Flow into Well 107 (107A)			
	c) Flow out Well 107 (107B)			
15	a) Pressure into Well 201 (found in well vault)			
	b) Flow into Well 201 (201A)			
	c) Flow out Well 201 (201B)			
16	a) Pressure into Well 202 (found in well vault)			
	b) Flow into Well 202 (202A)			
	c) Flow out Well 202 (202B)			
17	a) Pressure into Well 203 (found in well vault)			
	b) Flow into Well 203 (203A)			
	c) Flow out Well 203 (203B)			
18	a) Pressure into Well 204 (found in well vault)			
	b) Flow into Well 204 (204A)			
	c) Flow out Well 204 (204B)			

* Check all readings with the previous day's and note any differences and reason for that difference.

** For any equipment needing repair, indicate action taken to initiate these repairs.

WEEKLY CHECK FOR GROUND WATER SYSTEM

Week of ____/____/____ to ____/____/____

#	CHECK POINT	COMMENTS	INITIALS
1	Is there any vandalism on the system? (List location and extent of damage)		
2	Check each tray of the air stripper for any mineral deposits or bacterial growth.		
3	Is there any erosion across the system? (List location and extent)		

- * Check all information with the previous week's readings and note any difference.
- ** For any necessary corrective action, indicate action taken to initiate maintenance.

DAILY CHECK FOR SVE SYSTEM

Date ____/____/____

#	CHECK POINT	GAGE READING	COMMENTS	INITIALS
1	Stack: Is there any apparent damage?			
2	Is the discharge silencer functioning normally (are there any unusual noises?)			
3	Pressure between discharge silencer and vacuum pump PI 1300			
4	Temperature between discharge silencer and vacuum pump TI 1300			
5	Is the vacuum pump functioning normally?			
6	Is the inlet silencer functioning normally?			
7	What is the pressure reading on the air intake PI 1202?			
8	What is the flow reading on the air intake FI 1202?			
9	Is the air intake operating normally? (Has there been any vandalism?)			
10	What is the differential pressure across the in-line filter?			
11	Is the filter functioning normally?			
12	Where is the water level in the condensate trap? (If it is at the high port, it must be emptied, see maintenance section of O&M manual.)			
13	Is the condensate functioning normally?			
14	Is there any erosion across the system?			

* Check all readings with the previous day's and note any differences and reason for that difference.

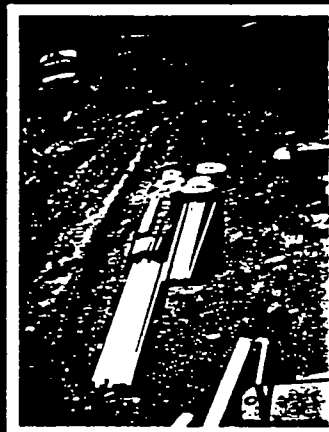
** For any equipment needing repair, indicate action taken to initiate these repairs.

APPENDIX B
WATERLOO MULTI-LEVEL GROUND WATER MONITORING SYSTEM

**Model: 401
Waterloo Multilevel
Groundwater Monitoring System***

For obtaining groundwater samples, hydraulic head and permeability measurements from many isolated zones in a single borehole.

Uses a simple modular system which is customized for each application. The System installs easily in standard boreholes sizes.



Features

- **Positive engineered seals.**
 - Waterloo packers for rock holes.
 - Dry-injected seals for overburden.
- **Flexible monitoring options.**
- **Dedicated Samplers.**
- **Economical.**

* Manufactured under exclusive licence from the University of Waterloo.
Canadian Patent No: 1232836. International patents pending.

*Instrumentation to measure the properties of
soil, rock and groundwater.*

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Why Multilevels

Groundwater flow is complex, especially in fractured bedrock. Without multilevel monitoring the actual or potential pathways for contaminant migration are difficult to identify.

● Accurate Assessment

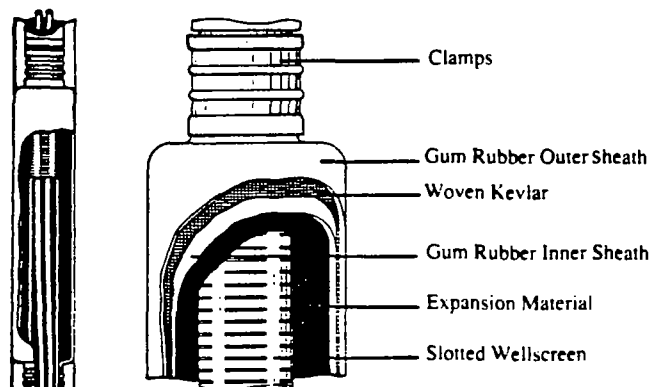
Multilevel monitoring in a number of boreholes at a site gives detailed three-dimensional data.

● Detailed Data

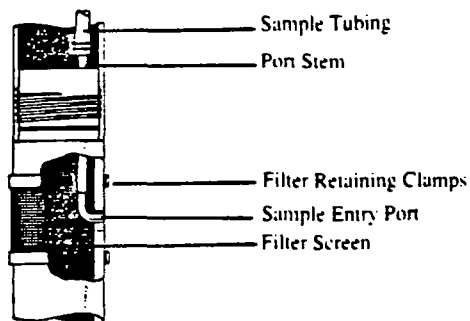
Multilevel monitoring maximizes the information available and reduces disturbance to the sub-surface. The Waterloo System provides for dedicated sampling to avoid cross-contamination.

● Economical

Multilevel systems also provide cost advantages over multiple piezometers. The Waterloo System maximizes these advantages. Drilling and installation costs are reduced. Little time is required to obtain each data set. Handling and disposal costs of purge water are minimized.



WATERLOO PACKER

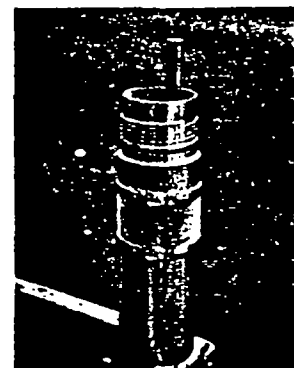
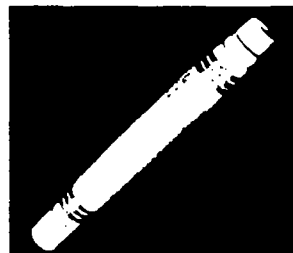


PORT

The System

The System uses modular flush-threaded components with specially designed double o-ring joints to form a sealed casing string. The casing string is made up of packers, ports, various casing lengths, a base plug and surface manifold. This allows accurate placement of entry ports at the zones to be monitored.

A monitoring tube is attached to the stem of each port. It individually connects that packed zone to the surface. The monitoring tubes are like miniature wells (piezometers). They are contained and protected within the sealed casing string.



The Waterloo Packer

The Waterloo packer uses a water activated expansion sleeve fitted over a length of wellscreen. A Rubber/Kevlar/Rubber sheath envelops the expansion material. The Kevlar layer provides strength to bridge across large fissures. The pliant pure gum rubber moulds to small fissures, ensuring that water does not leak around the packer.

The packer is inflated immediately after installation, when water is added to the inside of the sealed casing string. This water passes through the slotted wellscreen into the expansion sleeve, causing it to swell. Over the next 24-48 hours expansion continues until the permanently engineered seal is formed against the borehole wall.

Port Modules

The port modules are manufactured entirely of stainless steel. Formation water enters the port through a 75 micron stainless steel mesh filter, into the stem, up into the monitoring tube attached to that stem, and thus to its static level. If a dedicated sampling pump or pressure transducer is being used, it will be attached directly to the port stem.

Monitoring Options

Each monitoring port may be fitted with a dedicated sampling pump or pressure transducer. This maximizes the speed with which each data set can be obtained, and avoids the use of downhole samplers or water level meters. The sampling pumps are activated at surface and are suitable for sampling many types of contaminants, including VOCs.

Alternatively an open tube may be attached to each port. This maximizes flexibility and allows more zones to be monitored in each System. Purging, sampling and pressure measurements, are conducted using special, narrow diameter, portable monitoring equipment suitable for VOC analysis.

A third option is to choose a mix of open tubes and dedicated sampling pumps. This combines some of the advantages of each type and maintains future flexibility.

If water sampling is not needed, the System can comprise numerous pressure transducers for multi-level pressure monitoring.

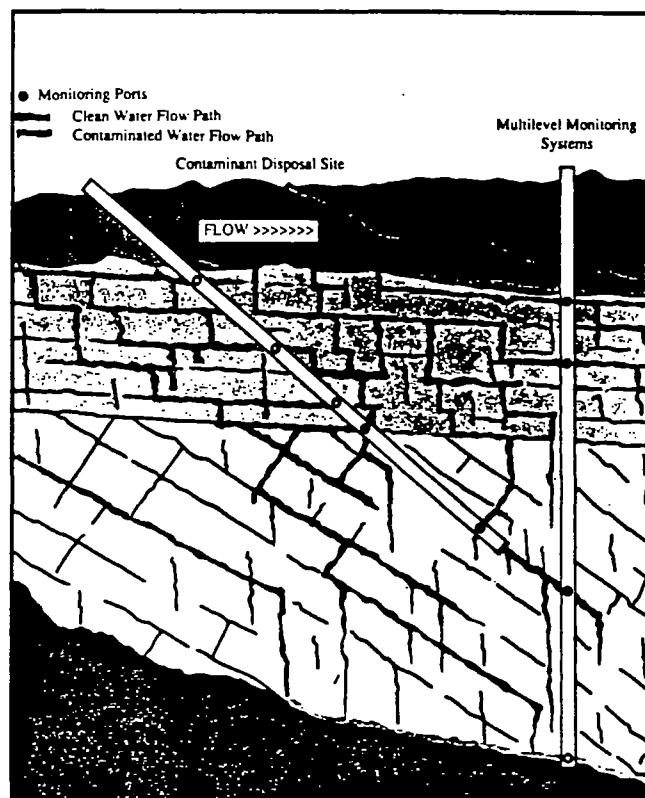


Overburden Applications

The Waterloo System can be adapted for use in overburden by omitting the Waterloo packers and placing bentonite and sand filter zones around the central casing string.

Accurate placement of seals and filters is achieved by the use of a special dry delivery method.*

The Waterloo System bedrock packers and overburden seals may be combined in the same borehole.



Schematic showing the benefits of using the Waterloo System in complexly fractured bedrock with vertical and inclined boreholes.

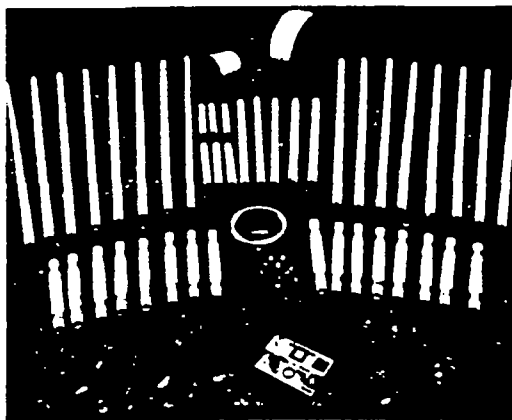
Bedrock Applications

The System was originally designed for use in bedrock applications. The unique Waterloo packer provides a permanently engineered seal in vertical or angled boreholes.

The seal does not deflate over time. This removes concerns about seal integrity, and avoids the need for periodic reinflation and the presence of permanent inflation lines.



* Manufactured under exclusive licence from Canada Patents & Developments.



Installs Quickly

Installation of the Waterloo System is quick and easy. A complete System can be installed by one technician and an assistant, in a few hours, without use of a drill rig.

Starting with the base plug and lower most sections, the components are threaded together as required. As each new port is put into position a new monitoring tube is connected to it. Successive components are threaded over these tubes, building the casing string, until the System is complete.

All joints in the System, including the base plug are fitted with double O-Ring seals. This provides a water-tight seal and prevents contact between packer inflation water inside the casing and the formation water outside the casing.



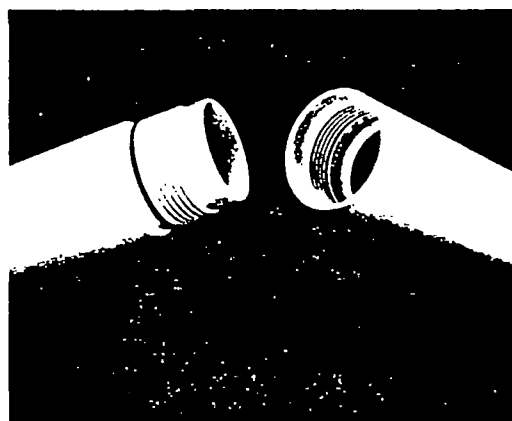
System Flexibility

The Waterloo System is extremely flexible. Each System is customized to fit:

- monitoring needs.
- site conditions.
- budget constraints.

Packers and ports can be accurately placed to monitor the zones of interest.

The maximum number of monitoring zones for a System is determined by the number of tubes and/or cables that will fit inside the casing string. This number is dependent on the borehole size, diameter of the System, and monitoring methods chosen.



Dedicated Instruments

For long term or frequent monitoring, dedicated sampling and pressure measurement equipment vastly reduces the time and effort required to obtain data and avoids cross contamination. A pressure transducer or dedicated gas-drive sampler is connected directly to the stem of each port.

Pressure measurements and permeability tests are most accurate and convenient when transducers are used. Measurements can be recorded automatically, and remotely. Different levels can also be measured simultaneously.

The System and control units are simple to use. Automatic control units and readouts have quick-connect couplings for fast attachment. Results/samples are easily and rapidly obtained, as instruments need not be lowered down the hole.

Purging can be automated. An optional multi-purge manifold can be used to permit purging from several levels simultaneously with one control unit,

Designing Your System

The options eventually chosen for each System will be site and application specific. The design is dependent on:

- borehole size
- zones of interest
- monitoring methods preferred
- cost considerations.

The standard Waterloo System is installed in a 3" (75mm) borehole. It comprises packers, a 2" (50mm) PVC casing string, stainless steel ports and polyethylene tubing.



Seal Length

The effective seal length between monitoring zones can be varied to suit the geology of the site by using multiple packers.



Size

To increase the number of intervals available, a larger diameter borehole may be used, along with an appropriate increase in casing, port and packer size.

Special oversized packers can be used to install standard size Systems in existing, larger boreholes.

Retrofitting Existing Holes

At sites where open boreholes already exist, the Waterloo System can be installed to create a useful and effective monitoring site.

Materials

For particular applications specific materials may be chosen. These may include stainless steel casing and packer bodies, stainless steel or Teflon® tubing. Viton® packer sheaths, or other materials as appropriate.

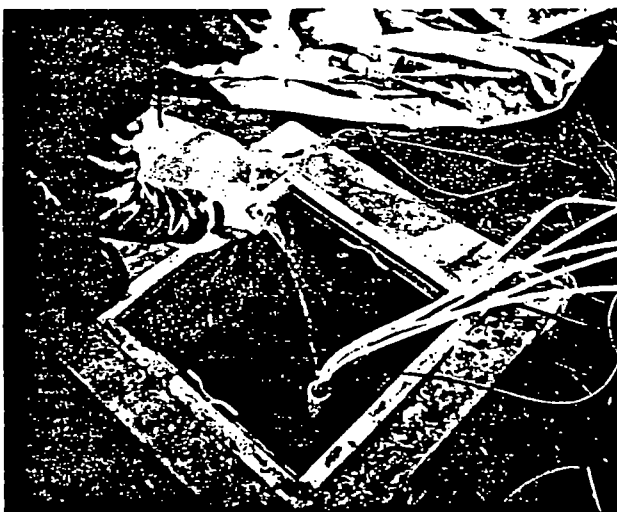
* Teflon and Viton are registered trademarks of Dupont.



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750ft. (230m) installation for a deep tunnel assessment study. Three zones monitored with dedicated Double-Valve Pumps and pressure transducers. Installed by two technicians in two days. Picture shows technician obtaining pressure measurements and groundwater samples with portable readout and control unit.



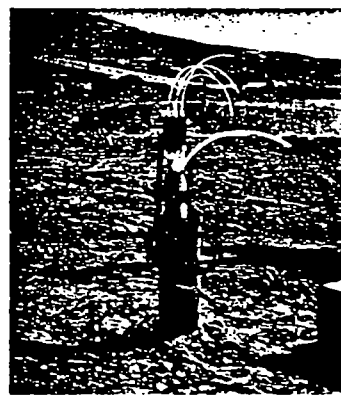
Previous waste disposal site over shale and sandstone. Waterloo Systems used to assist in defining the organic plume. 3" (75mm) dia. holes to 250 ft. (75m) utilising dedicated double-valve pumps and vibrating wire transducers, with 5 monitoring zones per borehole. Picture shows water being added to central casing string to expand the packers prior to fitting the sampling manifold. Manhole is designed to protect and locate the manifold below ground surface.

Applications

The Waterloo System has been specified by various industries and consulting professionals for numerous sites across the United States, Canada and overseas. Several sites have Superfund or RCRA designations.

The System has been used for:

- o defining groundwater flow patterns.
- o determination of aquitard leakiness.
- o pumping test monitoring.
- o performance monitoring of pump and treat systems.
- o identification and determination of spatial distribution of contaminants.



Landfill site over fractured granite, monitored with five Waterloo Systems. Each System comprised of dedicated Double Valve Pumps and Pressure Transducers in 4-6 intervals to depths of 275 feet (84m). A multipurge manifold was supplied by Solinst to allow simultaneous purging of all zones in each Multilevel System.



Water supply aquifer in soft sandstone. A 2-1/2" (63mm) dia. System to 360ft. (110m) to determine the effects of open boreholes on groundwater flow and chemistry. Seven zones each monitored with dedicated pumps and vibrating wire transducers. Hole diameter varied from 4" (100mm) to 6" (150mm) which required oversized packers of different sizes.

Projects

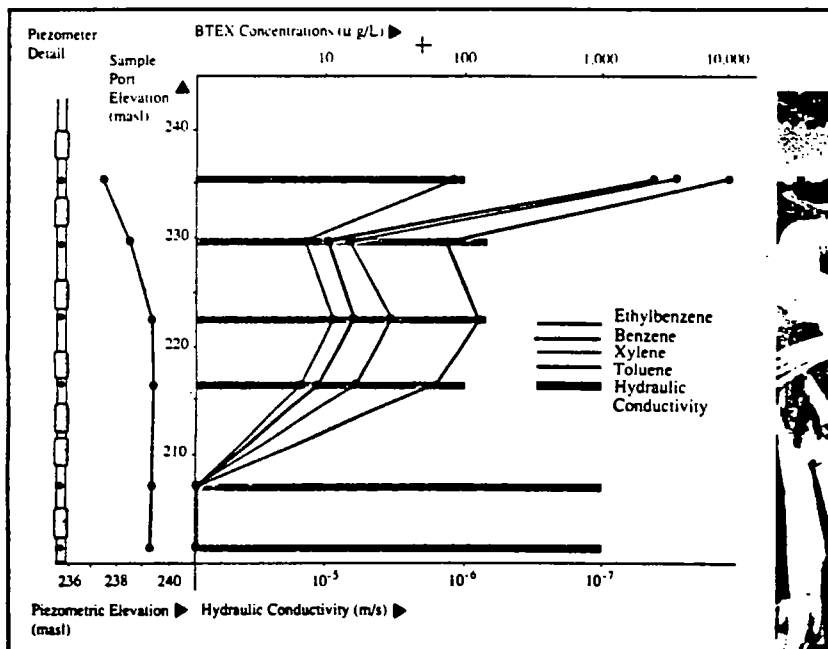
Projects on which Waterloo Systems have been used include:

- o Waste disposals/landfills.
- o Tailings storage.
- o Dam leakage/rehabilitation.
- o Tunnels.
- o Pipeline leaks.
- o Underground storage tanks.
- o Salt water intrusion.
- o Deep well injection impacts.
- o Contaminant identification/cleanup.
- o Industrial site cleanups.
- o Organics plume delineation.



Landfill site over shale bedrock. Four 2" (50mm) dia. Systems to 200 ft. (60m). Six monitoring zones per hole with open tubes for both pressure measurements and sampling. Systems all angled to intersect near-vertical fracture sets. The Waterloo System was used to define the complex groundwater flow pattern at this site. (Note: Drilling rig not required in the installation process.)

Data set obtained from oil pipeline leak assessment.



Underground oil pipeline leak assessment. Three 150 ft. (45m) installations, monitored with portable Water Level Meter and Triple Tube Sampler. Two point rising head permeability tests conducted in each interval of the Multilevel System.

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APPENDIX C
QA PROCEDURES FOR FIELD EQUIPMENT

A.1 Calibration of Field Equipment

A.1.1 Specific Conductance -Temperature Probe

This instrument is checked for accuracy by using a potassium chloride solution of known specific conductance and a reference thermometer. The check is performed daily and the readings must agree to 5 percent of the correct values. Four replicate measurements are made and averaged to ensure precision. Specific instrument procedures are found in the operator's manual.

A.1.2 pH Meter

The field pH meters are calibrated frequently throughout the day with three buffer solutions (pH 4, 7, and 10). The instrument is calibrated on two points, usually 4 and 7, and then the pH 10 buffer is read. Slope stability of the pH probe must be 90-100%. Specific instrument procedures are found in the operator's manual.

A.1.3 Organic Vapor Analyzer

The OVA will be calibrated three times, at the start and end of each day's use, and at mid-day, as follows:

Gain Adjustment

- a) Place instrument in normal operation with CALIBRATE Switch set to X10 and GAS SELECT control set to 300.
- b) Use the CALIBRATE ADJUST (zero) Knob and adjust the meter reading to zero.
- c) Introduce a methane sample of a known concentration (near to 100 ppm) and adjust trimpot R-32 on circuit board so that meter reads equivalent to the known sample.
- d) This sets the instrument gain for methane with the panel mounted gain adjustment (GAS SELECT) set at a reference number of 300.
- e) Turn off H2 SUPPLY VALVE to put out flame.

Bias Adjustment

- a) Leave CALIBRATE Switch on X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to 4 ppm.
- b) Place CALIBRATE Switch in X1 position again. Use CALIBRATE ADJUST (zero) Knob to adjust meter to a reading of 40 ppm.
- d) Move CALIBRATE Switch to X100 position and use trimpot R-33 on circuit board to adjust meter reading to 40 ppm.

- e) Move CALIBRATE Switch to X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to zero.
- f) Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.

A.1.4 HNu Model PI-101 Portable Photoionization Analyzer

The HNu will be calibrated at the start and end of each day's use using the calibration gas supplied by the manufacturers and according to the following procedure:

- Identify the probe by the lamp label.
- Connect the probe to the readout assembly.
- Set the SPAN pot to the proper value for the probe being calibrated.
- Check the Ionization Potential (IP) of the calibration gas to be used. The IP of the calibration gas must be at or below the IP of the lamp.
- Proceed with the calibration. Check the calibration memo for specific data.
- Battery check - Turn the function switch to BATT. The needle should be in the green region. If not, recharge the battery.
- Zero set - Turn the function switch to STANDBY. In this position the lamp is OFF and no signal is generated. Set the zero point with the ZERO set control.
- 0-20 or 0-200 range - For calibrating on the 0-20 or 0-200 range only one gas standard is required. Turn the function switch to the range position and note the meter reading. Adjust the SPAN control setting as required to read the ppm concentration of the standard. Recheck the zero setting. This gives a two-point calibration; zero and the gas standard point. Additional calibration points can be generated by dilution of the standard with zero air if desired.
- 0-2000 range - For calibrating on the 0-2000 range, use of two standards is recommended. First calibrate with the higher standard using the SPAN control for setting. Then calibrate with the lower standard using the ZERO adjustment. Repeat these several times to ensure that a good calibration is obtained. The analyzer will be approximately linear to better than 600 ppm. If the analyzer is subsequently to be used on the 0-20 or 0-200 range, it must be recalibrated.
- Lamp cleaning - If the span setting resulting from calibration is 0.0 or if calibration cannot be achieved, then the lamp must be cleaned.
- Lamp replacement - If the lamp output is too low or if the lamp has failed, it must be replaced.

Rapid calibration checking in the field can be accomplished by use of a small disposable cylinder containing isobutylene. Immediately after a calibration has been completed, a reading

is taken on a special isobutylene standard. This provides a reference concentration measurement for later checking in the field. This can be done at any time with a portable cylinder containing this same special standard, using this reference reading as a check, and making adjustments to the analyzer if necessary. In effect, this is an indirect method of calibration, one maintaining the calibration to give direct readings for the original gas mixture, but using the portable isobutylene cylinder. Details are given in Section 8.2 of the Appendix.

A.1.5 Personal Air Pumps

A precision Rotometer will be used as the secondary calibration device and will be calibrated no less than once per month against a bubble meter (the primary standard).

A.1.6 Explosimeter and Oxygen Detector

Portable Combustible Gas Indicator Johnson Instruments Model GP-204. The GP-204 will be calibrated using the calibration Potentiometer. This adjustment is used to set the meter reading to the desired level, while sampling a known concentration of combustible gas. In the GP-204, the top plate must be removed by taking out the screws in each corner. The calibration potentiometer is a slotted-shaft control located on the upper right hand corner of the meter. Turn clockwise to increase meter reading.

A.2 Specific Equipment Startup and Use Procedures

A.2.1 Organic Vapor Analyzer

The GAS SELECT control should be turned to the desired dial setting prior to being turned on. The procedure for determining this setting is contained in Section 4 of this manual. The instrument, as received from the factory, is set to measure in terms of methane in air.

- a) Move the INSTR Switch to ON and allow five minutes for warm up.
- b) To set the audible alarm to a predetermined level, first turn the PUMP Switch to ON, then adjust the meter pointer to the desired alarm level, using the CALIBRATE ADJUST (zero) Knob. Turn the Alarm Level Adjust Knob on the back of the Readout Assembly until the audible alarm just comes on. Adjust speaker volume with VOLUME Knob. If earphone is used, plug in and readjust the volume as desired. The instrument is then preset to activate the alarm when the level exceeds that of the setting.
- c) Move the CALIBRATE Switch to X10 and adjust the meter reading to zero with the CALIBRATE ADJUST (zero) Knob.
- d) Ensure the PUMP Switch is ON and observe the SAMPLE FLOW RATE Indicator. Indication should be approximately 2 units.
- e) Open H2 TANK VALVE one (1) turn and observe the reading on the H2 TANK PRESSURE Indicator. (Approximately 150 psi of pressure is needed for each hour of operation).

- f) Open H2 SUPPLY VALVE 1/2 to 1 turn and observe the reading on the H2 SUPPLY PRESSURE Indicator.

CAUTION

Do not leave H2 SUPPLY VALVE open when the pump is not running, as this will allow hydrogen to accumulate in the detector chamber.

- g) Confirm that meter is still reading zero (readjust if required).
- h) Depress igniter button. There will be a slight "pop" as the hydrogen ignites and the meter pointer will move upscale of zero. Immediately after ignition, release the igniter button. Do not depress igniter button for more than 6 seconds. If burner does not ignite, let instrument run for several minutes and try again. After ignition, the meter pointer will indicate the background concentration. This background level is nulled out using the CALIBRATE ADJUST (zero) Knob.

NOTE

Since the OVA utilizes the sample air drawn by the pump into the detector chamber as the only source of air to support the hydrogen flame, without adjustment the instrument will read the actual background concentration (ppm) of all hydrocarbons present at a given location.

- i) Move instrument to an area which is representative of the "lowest ambient background concentration" (cleanest air) to be surveyed. Move the CALIBRATE Switch to X1 and adjust the meter to read 1 ppm with the CALIBRATE ADJUST (zero) Knob.

NOTE

Adjustment to 1 ppm (rather than 0) is necessary in the X1 range because of the sensitivity of the OVA. This permits minor downward fluctuations in the normal background level without dropping below 0, which would actuate the flame-out alarm. It is important, therefore, to remember during the subsequent survey that 1 ppm must be subtracted from all readings. Therefore, a 1.8 ppm reading would actually be only 0.8 ppm.

- j) If the alarm level is to be set above the normal background detection level, turn the Alarm Level Adjust Knob on the back of the Readout Assembly until it actuates slightly above background.

THE INSTRUMENT IS NOW READY FOR USE.

OPERATING PROCEDURES

- a) Set the CALIBRATE Switch to the desired range. Using one hand operation, survey the areas of interest while observing the meter and/or listening for the audible alarm indication. For ease of operation, carry the Side Pack Assembly positioned on the side opposite the hand which holds the Probe/Readout Assembly. For broad surveys

outdoors, the pickup fixture should be positioned several feet above ground level. When making quantitative reading or pinpointing, the pickup fixture should be positioned at the point of interest.

- b) When organic vapors are detected, the meter pointer will move upscale and the audible alarm will sound when the present point is exceeded. The frequency of the audible alarm will increase as the detection level increases.
- c) If the flame-out alarm is actuated, ensure that the pump is running, then press the igniter button. Under normal conditions, flame-out results from sampling a gas mixture that is above the lower explosive level which causes the H₂ flame to extinguish. If this is the case, reignition is all that is required.
Another possible cause for flame-out would be restriction of the sample flow line which would not allow sufficient air into the chamber to support combustion of the H₂ flame. The normal cause for such restriction would be a clogged particle filter or other restriction in the line. It should be noted that the chamber exhaust port is on the bottom of the case and blocking this port with the hand will cause fluctuations and/or flame-out.

A.2.2 HNu Model PI-101 Portable Photoionization Analyzer

The following procedures are to be used in operating the analyzer:

- a) Unclamp the cover from the main readout assembly.
- b) Remove the inner lid from the cover by pulling out the two fasteners.
- c) Remove the probe, handle and cable from the cover. Attach the handle to the front part of the probe.
- d) Connect the probe cable plug to the 12 pin keyed socket on the readout assembly panel. Carefully match the alignment slot in the plug to the key in the connector. Screw down the probe connector until a distinct snap and lock is felt.
- e) Screw the probe extension into the probe end cap. The probe may be used without the extension if desired.
- f) Set the SPAN control for the probe being used (10.2, 9.5, or 11.7 eV) as specified by the initial factory calibration or by subsequent calibrations.
- g) Turn the function switch to the BATT (battery check) position. The needle on the meter will go to the green zone if the battery is fully charged. If the needle is below the green arc or if the Low Battery Indicator comes on, the battery must be recharged before the analyzer is used.
- h) Set SPAN pot to the desired value based on the gas to be used.
- i) Turn the function switch to the STANDBY position. Turn the zero adjustment until the meter needle is at zero.

- j) Calibrate the instrument daily as described in Section B.1.4. Calibration on the selected operating range is desirable.
- k) If equipped with optional alarm, set or check the alarm setting at the level desired. Turn the function switch to the desired range, turn the zero adjustment control so the meter needle moves upscale through the desired value. This simulates real conditions. Observe the reading when the alarm sounds. Adjust the ALARM SET, if required, with a screw driver. Turn the function switch to the STANDBY position and reset the zero position (par. h. above). If the range is to be changed, the alarm must be reset on that range.
- l) To operate with optional recorder, add the recorder bracket. Remove the plug in the analyzer case and insert power cord into the recorder. Then connect the signal leads to the appropriate jacks in the control module. The recorder is now operational.

NOTE: Ranges must be marked on the chart as the recorder prints the meter display as % of Full Scale.

- m) Turn the function switch to the appropriate operating position. Start with the 0-2000 position and then switch to the more sensitive ranges. The UV light source should be on, confirmed by briefly looking into the probe to observe a purple glow from the lamp.

Do not look at the light source closer than 6 inches with unprotected eyes. Observe only if necessary, then only briefly. Continued exposure to ultraviolet energy generated by the light source can be harmful to eyesight.

- n) The analyzer is now operational.
- o) Hold the probe so that the extension is at the point where the measurement is to be made. The instrument measures the concentration by drawing the gas in at the end of the extension, through the ionization chamber, and out the handle end of the probe. The instrument measures gases in the vicinity of the operator and a high reading when measuring toxic or explosive gases should be cause of action for operator safety.
- p) Take the reading or readings as desired taking into account that air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings. Change the ranges as required.
- q) Check battery condition as required. If the Low Battery Indicator comes on, turn analyzer off and recharge. Use only in an emergency with a lower battery when on battery charge.
- r) After completion of use, check battery condition as described in para. g.
- s) Turn function switch to OFF position.
- t) When not operating, leave analyzer in assembled condition, and connected to battery charger.

- u) When transporting, disassemble probe and extension from readout assembly and return equipment to its stored condition.
- v) In case of emergency, turn function switch to OFF position.

A.2.3 Portable Combustible Gas Indicator Johnson Instruments Model GP-204

Operation

Before taking instrument on the job, check battery voltage. To check, put switch in VOLT ADJ position. Meter should rise to the "CHECK" position near top of scale. Lift and turn VOLT ADJ. control clockwise to determine maximum voltage setting. If it cannot be set beyond mark, batteries need recharging or replacement for full capacity. Do not attempt to use instrument at all if reading cannot be set up to mark.

If voltage is satisfactory, continue with the next steps of preliminary adjustment as follows:

1. Confirm operation of pilot light/meter illuminating lamp.
2. With sample inlet in fresh air, squeeze bulb several times to flush out any remaining gas.
3. Check zero setting by turning switch to ON position. Meter should read close to zero. Lift and turn ZERO knob to bring reading to exactly 0.
4. Couple sampling hose to instrument inlet on left-hand end, and connect probe to end of hose.
5. Admit a sample of some combustible gas to end of probe, and confirm that meter rises upscale.

Instrument is now adjusted and ready to use. It may be turned off and carried to the job. To make a gas test, proceed as follows:

1. Turn to VOLT ADJ. position, adjust voltage if necessary, then turn to ON.
2. Hold probe within space to be tested. Squeeze bulb several times while watching meter, and observe maximum reading.
3. After completion of test, remove probe from test space, flush with fresh air for 4 or 5 squeezes of bulb, and turn off.



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**MEDLEY FARM SITE
GAFFNEY, SOUTH CAROLINA**

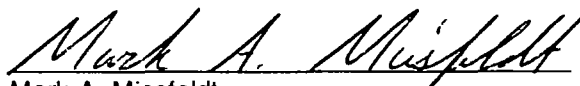
REMEDIAL DESIGN AND REMEDIAL ACTION

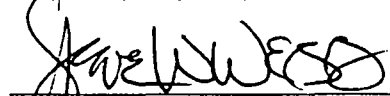
**PERFORMANCE STANDARDS VERIFICATION
QUALITY ASSURANCE PROJECT PLAN**

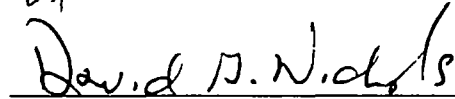
May 1993

*Prepared for the
Medley Farm Site Steering Committee*


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PREFACE

United States Environmental Protection Agency (US EPA) and the Medley Farm Site Steering Committee have entered into a Consent Decree. As a part of this agreement, the Medley Farm Site Steering Committee agreed to provide the US EPA with a Performance Standards Verification Plan that included the following:

- Field Sampling and Analysis Plan (FSAP), and
- Quality Assurance Project Plan (QAPP).

The required Field Sampling and Analysis Plan and the Quality Assurance Project Plan have been combined as integral parts of this Performance Standards Verification Plan.

Section 1 PROJECT DESCRIPTION

The Performance Standards Verification Quality Assurance Project Plan (PSVQAPP) presented in this document has been prepared to address the Remedial Design (RD) and Remedial Action (RA) for the Medley Farm site, located near Gaffney, South Carolina (Figure 1-1). It has been prepared in accordance with US EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," (QAM-005/80, December 29, 1980). This PSVQAPP is provided as supporting documentation for the RD/RA Prefinal/Final Design Report for the Medley Farm site. Applicable sampling/monitoring schedules and detailed procedures for sample collection, sample numbers, and locations are given in the Performance Standards Verification Field Sampling and Analysis Plan (PSVFSAP).

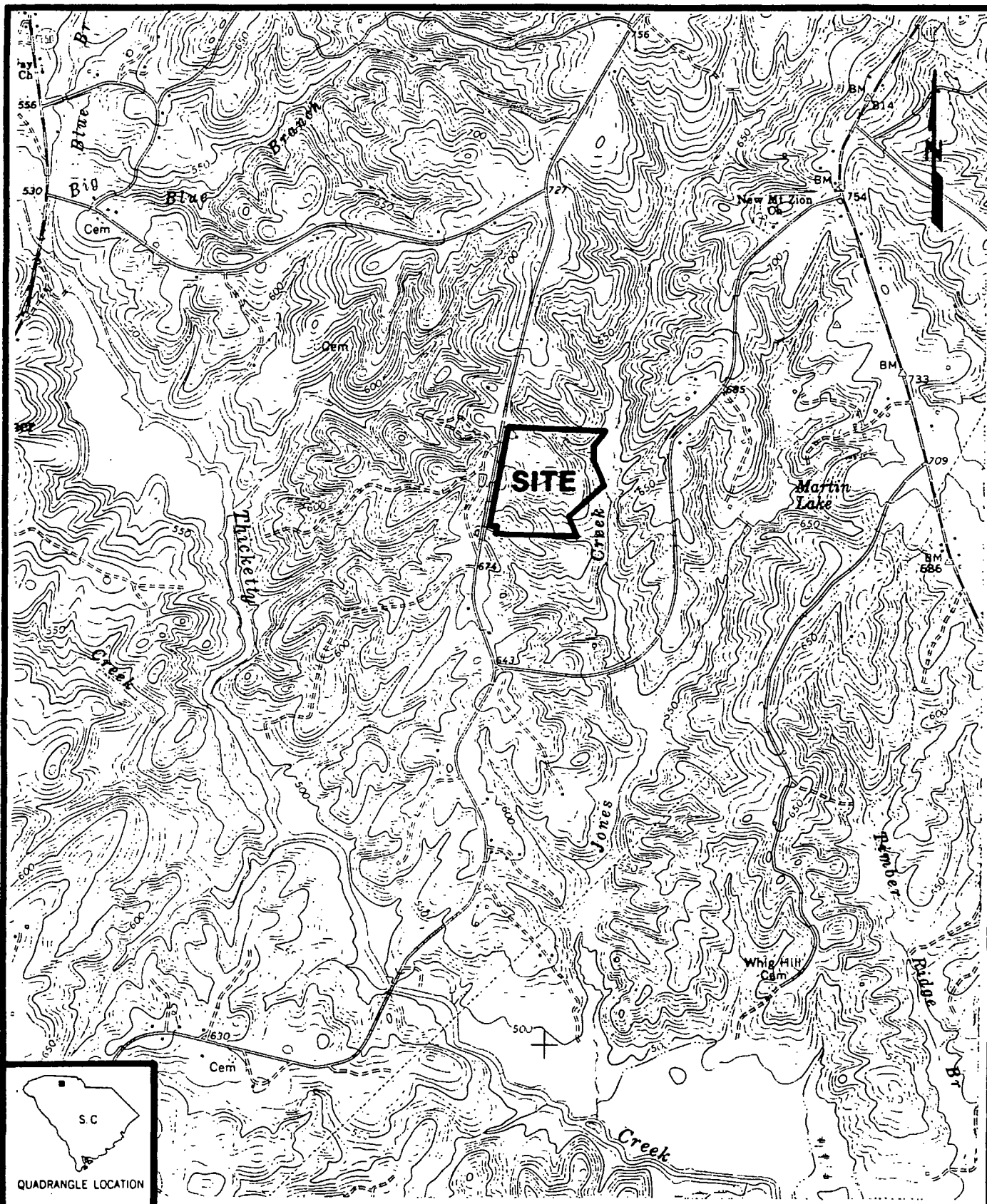
1.1 Project Objectives

The remedial objectives of the ground water and soil vapor extraction systems developed for the Medley Farm Site are discussed in the US EPA's Record of Decision (ROD) and Prefinal/Final Design Report. The objectives of this PSVQAPP are to outline specific procedures that will be implemented to assure and control the quality and integrity of sample collection and analysis during the course of the RD/RA process. This PSVQAPP also establishes QA/QC procedures for field notes, data transcription, and data archival.

1.2 Criteria for Evaluating Data In Terms of Study Objectives

The data collected will be used to meet the requirements of the study objectives, which will be evaluated through a combination of the following criteria:

- Comparison to Background Concentrations - Background samples will be collected in the study area to establish background concentrations present. Data will be compared to background concentrations to determine if elevated concentrations are present and to assess progress toward meeting the ROD stated cleanup levels.
- Comparison to Known Environmental Quality Standards - Constituents that have defined environmental quality standards for water or soil will be evaluated in terms of those standards to evaluate the effectiveness of the ground water and soil vapor extraction systems.
- Comparison to Existing Site Analytical Data - New data will be compared to historical data to determine trends in constituent concentration and evaluate the effectiveness of the remedial system and appropriateness of the performance monitoring analytical program..



PACOLET MILLS QUAD.

FIGURE 1-1
SITE LOCATION MAP
SCALE: 1"=2000'

RMT MC 938.04
0292

MEDLEY FARMS
GAFFNEY, SC.

1.3 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements which specify the quality of the data required to support decisions made during RD/RA activities and are based on the end uses of the data to be collected. As such, different data uses may require different levels of data quality.

There are five analytical levels which address various data uses and the QA/QC effort and methods required to achieve the desired level of quality. These levels are:

- Screening (DQO Level 1): This provides the lowest data quality but the most rapid results. It is often used for health and safety monitoring at the site, preliminary comparison to ARARs, initial site characterization to locate areas for subsequent and more accurate analyses, and for engineering screening of alternatives (bench-scale tests). These types of data include those generated on-site through the use of OVA, pH, conductivity, and other real-time monitoring equipment at the site.
- Field Analyses (DQO Level 2): This provides rapid results and better quality than in Level 1. This level may include mobile lab generated data depending on the level of quality control exercised. This level would address the field analysis of volatile organic compounds using a portable gas chromatograph (GC).
- Engineering and Performance Standards Verification (DQO Level 3): This provides an acceptable level of data quality and is used for site characterization. Engineering and Performance Standards Verification analyses may include analytical lab methods for addressing such issues as scaling, corrosion, treatability, or other such engineering concerns, as well as verification analyses conducted during the operation of the remediation system. These analyses would be conducted using EPA SW-846 methods, where applicable. RMT expects the Remedial Action and long-term monitoring to be conducted primarily at this level.
- Confirmational (DQO Level 4): This provides the highest level of data quality and is used for purposes of risk assessment, evaluation of remedial alternatives and PRP determination. These analyses require full Contract Laboratory Program (CLP) analytical and data validation procedures in accordance with EPA recognized protocol. RMT has used this level throughout the Remedial Design.
- Non-Standard (DQO Level 5): This refers to analyses by non-standard and protocols (e.g., when lower detection limits, or extraction and analysis of an unusual chemical compound is required). These analyses often require method development or adaptation. The level of quality control is usually similar to DQO Level 4 data. No DQO Level 5 analyses are planned or anticipated.

Section 2

PROJECT ORGANIZATION AND RESPONSIBILITY

Personnel involved in the investigation, and in the generation of data as a result of investigation activities, become a part of the overall Project Quality Assurance program. Within that program, the following individuals have specific responsibilities: the Project Manager, the Project Coordinator(s), the Laboratory Coordinator, and Field Sampling Technician(s). Specific laboratory personnel with Quality Assurance/Quality Control responsibilities include the Laboratory Quality Assurance Officer and the Laboratory Sample Custodian.

2.1 Project Manager

The Project Manager for this investigation is responsible for general oversight of work to be conducted. The Project Manager also oversees scheduling and budgeting.

2.2 Project Coordinator(s)

A Project Coordinator is assigned to large-scale projects where the Project Manager cannot be present for all on-site activities. The Project Coordinator is primarily responsible for project Quality Assurance activity. The Project Coordinator's responsibilities include the development, evaluation, and documentation of the Quality Assurance Project Plan, including procedures appropriate to the investigation. The Project Coordinator will guide personnel in achieving a thorough understanding of the project Quality Assurance plan and their respective roles relative to one another within the established project framework.

The Project Coordinator is also responsible for the day-to-day activities of contractor field personnel. In this capacity, the Project Coordinator is responsible for the Quality Assurance of daily project activities and the maintenance of the Quality Assurance Project Plan. Further responsibilities include the review of field notebooks, driller's logs, and other field-related documentation.

2.3 Field Sampling Technician(s)

The Field Sampling Technicians are responsible for on-site sampling and sample handling activities. This includes proper labeling and security, chain-of-custody, analysis request forms, packaging and shipping.

2.4 Laboratory Coordinator

A Laboratory Coordinator is assigned to CERCLA projects to facilitate communication between project and laboratory staffs for unusual problems encountered during the field work which require special communication between the analytical laboratory, field personnel, and the consulting staff. The Laboratory Coordinator is responsible for coordinating field sampling and laboratory activities, performing data QA reviews, and maintaining clear communication between laboratory and field personnel.

2.5 Laboratory Quality Assurance Officer

The nature of analytical work for this project necessitates that the analytical laboratory specify a Laboratory Quality Assurance Officer whose duties are specific to the project. The Laboratory Quality Assurance Officer is responsible for maintenance of Laboratory Quality Assurance activities associated with the project.

2.6 Laboratory Sample Custodian

The Laboratory Sample Custodian is responsible for assuring that proper sample entry, internal laboratory and external shipping chain-of-custody, and sample handling procedures are followed by laboratory personnel.

Section 3

PERFORMANCE STANDARDS VERIFICATION QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Data quality requirements are based on the intended use of the data, the measurement process, and the availability of resources. Data quality requirements include detection limits, accuracy, and precision. Quality Assurance protocols for the analytical methods to be used and the analyses to be conducted. Specific guidelines for accuracy, precision, completeness, and representativeness are discussed in the following subsections. Field blanks, trip blanks, decontamination evaluation (i.e., "rinsate") blanks, and field duplicates described in Section 11 of this QAPP will be subjected to the same Quality Assurance objectives as samples.

3.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted reference or true value. The project-specific QA objectives established for accuracy are expressed in the following parameters.

3.1.1 Reference Materials

Reference materials used as calibration standards or surrogate compounds will be certified, commercially available materials.

3.1.2 Instrument Performance

Instruments used in this project will be checked each day that samples are analyzed to demonstrate instrument performance. The QA objectives for instrument sensitivity, calibration, and performance are established in US EPA CLP, other US EPA protocols (e.g., SW-846), or other analytical procedures referred to in Section 9 of this QAPP.

3.1.3 Recovery of Surrogates

Surrogate compound recovery is utilized to evaluate proper performance of the analytical method and/or possible matrix interference to the analytical method for organic compounds.

The recovery of a surrogate compound (S) added to a sample will be defined as follows:

$$\text{Recovery \%} = \frac{\text{ug S found in sample}}{\text{ug S added to sample}} \times 100$$

This equation assumes that the surrogate is not present in the sample. The objectives for recovery of surrogates from water and soil matrices are given in US EPA SW-846 analytical methods.

3.1.4 Recovery of TCL Analytes

The recovery of analytes from samples will be evaluated using matrix spikes. Representative analytes will be added ("spiked") into samples. Matrix spikes and matrix spike duplicates will be performed at the frequency specified in the CLP Protocol. The spike recovery of an analyte (X) will be defined as follows:

$$\text{Spike Recovery (\%)} = \left(\frac{\text{ug X found in spiked sample} - \text{ug X in native sample}}{\text{ug X added to sample}} \right) \times 100\%$$

Spike recovery data is used to check for possible sample matrix interferences. The objectives for the spike recovery from soil and water matrices are given in US EPA SW-846 analytical methods.

3.2 Precision

Precision is defined as a measure of mutual agreement among individual measurements of a sample property. The project QA objectives established for precision are expressed in the following parameters.

3.2.1 Analysis of Standards

One of the QA objectives for this project is that each initial calibration curve and subsequent (i.e., "continuing") calibration standards meet or exceed the minimum QA criteria established in the US EPA SW-846 analytical methods.

3.2.2 Analysis of Spiked Samples

A second QA objective for this project is that the results of spiked samples (i.e., matrix spikes) and spiked sample duplicates (i.e., matrix spike duplicates) be within the advisable recovery and Relative Percent Difference (RPD) limits specified in US EPA SW-846 methodologies, as applicable.

3.2.3 Analysis of Duplicate Samples

A third QA objective for this project is that analyte concentrations be comparable within duplicate samples. This includes 1) duplicate samples collected in the field, 2) duplicate analyses resulting from matrix spike and matrix spike duplicate samples, and 3) results generated from multiple analyses of a sample performed at the laboratory.

A measure of precision is Relative Percent Difference (RPD) of two analyses of the same sample. This measure is applied as a quality control criterion to the recovery of organic matrix spike compounds. RPD is defined as follows:

$$RPD = \frac{|\text{First Analysis Value} - \text{Second Analysis Value}|}{(\text{First Analysis Value} + \text{Second Analysis Value})/2} \times 100\%$$

RPD criteria for organic matrix spike compounds are given in US EPA SW-846 analytical methods.

3.3 Completeness

The QA completeness objective for this program is to obtain analytical results for at least 95 percent of the samples submitted for analyses.

3.4 Representativeness

Sampling sites, sampling frequency, sample preservation, sampling procedures, and sampling equipment will be addressed in the site-specific sampling and analysis plan to obtain representative samples.

3.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data, as documented in the QAPP, are expected to provide comparable data. These new analytical data, however, may not be directly comparable to existing data because of differences in procedures and QA objectives.

Data acquired for different purposes using different analytical methods, or different DQOs, may not be directly comparable. Samples analyzed using CLP (DQO Level 4) protocols are expected to be comparable. Comparison of data between DQO Level 4 (CLP) and DQO Level 3 (*e.g.*, SW-846) should be possible. Method detection/reporting for US EPA SW-846 methods should be comparable to those of the CLP protocol.

3.6 Field Measurement Data

Precision and accuracy for field pH and conductivity are dependent on the type and condition of the instrument used and the care used in standardization and operation of that instrument. The precision and accuracy objectives for the instrumentation used are as follows:

- The pH precision will be ± 0.3 pH standard units and an accuracy of ± 0.3 pH standard units. Field pH measurements will be reported to the nearest oil standard unit.
- Conductivity precision will be ± 3 umhos/cm on the 500 umhos/cm range, 25 umhos/cm on the 5,000 umhos/cm range and 250 umhos/cm on the 50,000 umhos/cm range. Accuracy for conductivity measurements are a function of the conductivity reading for the probe and instrument combined.

Section 4

SAMPLING PROCEDURES

Sample container, preservation procedures and holding time requirements are presented in Tables 4-1a and 4-1b. Precleaned sample containers will be obtained from sample bottle suppliers such as I-Chem Research, Inc., New Castle, Delaware, and Pierce Chemical Company, Rockford, Illinois. The preparation of sample bottles (e.g., preservative added) will be documented.

Detailed procedures for sample collection, number, and location are given in the PSVFSAP. The collection of blanks, duplicate samples, and spike samples will be discussed in Section 11 of this PSVQAPP.

When samples requiring preservation by either acid (except samples for volatile organic compound analysis) or base are received at the laboratory, the pH will be measured and documented. The pH will be adjusted by the Laboratory Sample Custodian, if necessary, and the Laboratory Coordinator will be promptly notified of the pH adjustment so that sample collection procedures can be reviewed to determine if a modification is necessary. The Laboratory Sample Custodian will then store the sample in a secure sample storage cooler maintained at 4°C and maintain custody until the sample is discarded.

QAPP TABLE 4-1a

**RECOMMENDED HOLDING TIMES FOR PRESERVATION PROCEDURES
AND CONTAINER TYPES FOR ANALYSES OF SOILS AND WATER SAMPLES**

SAMPLE ANALYSIS	HOLDING TIME ^a		PRESERVATION PROCEDURES		CONTAINER TYPE	
	WATER	SOIL/SEDIMENT	WATER	SOIL/SEDIMENT	WATER	SOIL/SEDIMENT
Volatile Organic Compounds	14 days	14 days	4°C, 4 drops 1:1 HCl	4°C	three 40 mL glass, Teflon lined septum (min.)	two 4 oz glass, Teflon lined lid (min.)
Chronic Toxicity	Initiate in 24 hours	---	4°C	---	one gallon amber plastic	---
Temperature, field pH, and Conductivity	Immediately after sample collected	---	---	---	---	---

^a Starting from time of sample collection.

QAPP TABLE 4-1b

**RECOMMENDED HOLDING TIMES FOR PRESERVATION PROCEDURES
AND CONTAINER TYPES FOR ANALYSES OF AIR SAMPLES**

SAMPLE ANALYSIS	HOLDING TIME ^a	PRESERVATION PROCEDURE	CONTAINER TYPE
	AIR	AIR	AIR
Volatile Organic Compounds		4°C	activated charcoal tube(s)

^a Starting from time of sample collection.

Section 5

SAMPLE CUSTODY

The field technician performing sample collection activities will be responsible for sample custody in the field. The laboratory sample custodian and analysts will be responsible for custody of the sample at the laboratory.

5.1 Field Chain-of-Custody

Prior to collecting samples in the field, the Field Sampling Technicians will obtain the sample bottles necessary for the field operation. Field samplers will label each sample collected, filling in the appropriate information in waterproof ink. The field sampler will be responsible for collecting the samples and for logging the samples into assigned field notebooks. The field sampling technicians will complete and verify the Chain-of-Custody forms (Figure 5-1). A copy of the Chain-of-Custody will be placed in the project files and the original will accompany the shipped samples. The identity of field duplicate samples will not be disclosed to the Analytical Laboratory. Sample analysis request forms (Figure 5-2) will be prepared by the Laboratory Coordinator, or prepared by a Field Technician and reviewed by the Laboratory Coordinator. The analytical request forms will accompany samples, or precede delivery of samples, to the laboratory.

5.2 Transfer of Custody

Shipping containers will be sealed and accompanied by the Chain-of-Custody record, with appropriate signatures. The transfer of custody is the responsibility of the Field Sampling Technicians and the laboratory.

5.3 Laboratory Custody Procedures

In the laboratory, a sample custodian will be assigned to receive the samples. Upon receipt of a sample, the custodian will inspect the condition of the samples, reconcile the sample(s) received against the Chain-of-Custody record, log in the sample(s) in the laboratory log book, and store the sample(s) in a secured sample storage room or cabinet until assigned to an analyst for analysis.

The sample custodian will inspect the sample for any leakage from the container. A leaky multi-phase sample will not be accepted for analysis as this sample would no longer be a representative sample.

F-268 (R2/92)
(Use Black Ink Only)

Dublin, OH
Waukesha, WI

№ 039908

[illegible]

WHITE - LABORATORY COPY

SAMPLES STORED yes SAMPLES RETURNED yes SAMPLES DISPOSED yes (Default = DISPOSED)

Submitter: _____ Report To: _____ Project Manager: _____ Project Number: _____ RMT Office: _____ Project Name: _____ Lab Price Quote Number: _____ Report Target Date: _____ (Default = 3 weeks) Quick Turn: 1 week _____ (with approval) Quick Turn: 2 weeks _____ (with approval)		(TO BE COMPLETED BY LABORATORY PERSONNEL) LIMS Work Order ID: _____ Analysis Target Date: _____ Technical Review By: _____ Date: _____ LIMS Entry By: _____ Date: _____ Sample Matrix: EPT EPW ATM TCP GW SW OTHER							
Parameter/Method	LIMS Test ID								Number of Samples
VOLATILES	a. 8010 / 801 b. 8020 / 802 c. 8030 / 803 d. 8140 / 814 e. 802.3 / SDWA f. 824.3 / SDWA g. TCL (HSL) h. PP i. TCLP - VOA j. Appendix IX k. Unknown volatiles	S/W VOA8010, WVOA801 S/W VOA8020, WVOA802 S/W VOA8030, WVOA803 S/W VOA 8140/814 S/W VOA803 S/W VOA814 S/W VOATCL S/W VOA1 TVOA10M S/W VOA1X UNKNOWNV							
TPH	a. Extraction b. Diesel c. Gas d. Kerosene	S/W TPHEXT S/W TPHCC S/W TPHGC1 S/W TPHGC2							
PCB/PEST	a. 808 / 8080 b. 808 / 8080 c. 8140 d. 8150 e. TCLP - Pesticide f. TCLP - Herbicide g. 805 / SDWA h. 818.1 / SDWA i. 807 / SDWA j. TCL (HSL) k. PP l. Appendix IX m. Extraction	S/W PCBPEST S/W PCB S/W OCP8140 SHRB8150 TPST7M THERB3M S/W PEST 805 S/W PEST 818 S/W PEST 807 S/W PCBPEST S/W PESTCL S/W PIX S/W EXT							
SEMIVOLATILES	a. 804 / 8040 b. 805 / 8050 c. 809 / 8090 d. 828 / PNA e. 811 / 8110 f. 812 / 8120 g. 825 / 8270 h. 828 / SDWA i. TCLP - BNA j. TCL (HSL) k. PP l. Appendix IX m. Extraction n. Unknown semi-volatiles	S/W ACID WBN2605, SBN26050 S/W BNAFPTH S/W PNA828 S/W HALO S/W CHYD WBNAG25, S/W BNA8270 WSDWA TBNAG13M WBNAG25, S/W BNA8270 WBNAG25, S/W BNA8270 S/W BNA1X S/W EXT UNKNOWNVB							
FIELD DATA	FLDDATA								

7-211C

PAGE 65

Figure 5-2b

RMT Laboratories - ORGANIC WORK ORDER FORM
Single Parameters

Parameter/Method	LIMS Test ID												Number of Samples
V O L A T I L E S 1. _____ 2. _____ 3. _____ 4. _____ 5. _____													
P C B / P E S T 1. _____ 2. _____ 3. _____ 4. _____													
S E M I / V O L A T I L E ACIDS 1. _____ 2. _____ 3. _____ BASE NEUTRALS 1. _____ 2. _____ 3. _____ 4. _____													
SPECIAL INSTRUCTIONS: _____ _____ _____												HAZARDS ASSOCIATED WITH SAMPLES: _____ _____ _____	

The custodian will examine whether the sample cooler seals are intact or broken. The Laboratory Coordinator will be promptly notified of broken seals so that appropriate action may be taken (*e.g.*, collect another sample).

Discrepancies observed between the samples received, the information that is on the Chain-of-Custody record, and the sample analysis request sheet will be resolved before the sample is assigned for analysis. The Laboratory Coordinator will be informed of any such discrepancy as well as its resolution. Results of the inspection will be documented in the laboratory sample log book. Discrepancies will be documented in the analytical case narrative, as appropriate.

5.4 Sample Labels

A self-adhesive sample label (Figure 5-3) will be affixed to each sample bottle before sample collection.

At a minimum, the sample label will contain the following:

- Client - Job Name/Project Number,
- Sample Identification,
- Date and Time Collected (except for duplicate samples),
- Sampler's Signature (or initials), and
- Preservatives Added.

Figure 5-3a Example of Sample Bottle Label

RMT^{INC} 100 VERDAE BLVD.
P.O. BOX 16778
GREENVILLE, SC 29606
(803) 281-0030

PRESERVATIVE (CIRCLE)
☒ NONE ☐ NaOH ☐ HNO₃ ☐ H₂SO₄
OTHER _____

PROJECT # (CLIENT) _____

SAMPLE ID _____

DATE/TIME _____

COLLECTOR _____

TYPE (CIRCLE) GRAB ☐ COMP ☐ FILTERED ☐ OTHER _____

ANALYZE FOR _____

LABORATORY # _____

Figure 5-3B Example of Sample Bottle Custody Seal

CUSTODY SEAL

Person Collecting Sample _____ (signature) Sample No. _____

Date Collected _____ Time Collected _____

Section 6 SHIPPING OF SAMPLES

Environmental samples will be transported as follows:

- 1) Collect the sample in appropriate containers.
- 2) Wrap glass sample containers in bubble wrap to protect from breakage. Small (less than 500 ml) glass containers will also be placed in plastic (e.g., Zip-Lock) bags.
- 3) Place the sample containers in a strong outside container such as a picnic cooler. Pour crushed ice around sample containers
- 4) Place the signed Chain-of-Custody forms inside the cooler. If analytical request forms have not already been sent to the laboratory, place them inside the cooler. Retain one copy of the signed Chain-of-Custody and store it in the project files.
- 5) Place two Initialed Custody Seals on opposite sides of cooler.
- 6) Each sample shipping container will be sealed with tape prior to shipping.
- 7) Clearly label each container's exterior with its destination.
- 8) Ship via air freight or other overnight carrier.

If samples are personally delivered to the laboratory by the sampling teams, steps 5, 6, 7, and 8 can be omitted.

Section 7

SAMPLING SITE LOCATION AND SAMPLING ACTIVITY IDENTIFICATION

7.1 Field Log Book

Information pertinent to the soil and ground water investigation will be recorded in field log books. Field log books will be bound, with consecutively numbered pages. The pages will be dated and signed by the person who is recording the information. Unused space at the bottom of a page will be crossed through. Work sketches or phrases that are recorded but deemed incorrect will be marked through in such a way as to still be legible, yet obviously struck from the text. Mark-throughs will be initialed and dated by the person striking the item.

Persons leading a sampling team or performing a distinct task will be issued a field log book by the Project Coordinator. That person will maintain the log book during the RD/RA. At the conclusion of the various phases of the RD/RA, the field books will be collected and reviewed by the Project Coordinator.

7.2 Photographs

Sampling site locations will be identified on a site map. The location will be cross-referenced in the field notebook as to the identification of samples collected from the site location. Photographs of the sampling site location and the activities occurring at a specific location may be taken. Photographs will be cross-referenced with an identification/explanation narrative in the field notebook.

Section 8

CALIBRATION PROCEDURES AND FREQUENCY

8.1 Laboratory Calibration

The calibration procedures to be used for this project are summarized below, and will follow US EPA SW-846 methodologies specified in Section 9 of this PSVQAPP and the associated PSVFSAP.

8.1.1 Instrument Performance and Tune

Prior to analysis of each set of samples and on a daily basis during the analysis, it will be demonstrated that the instrument meets the operating performance standards established in the appropriate analytical method. If an instrument does not meet the performance standards it will be tuned until the performance criteria are achieved.

8.1.2 Calibration Curve

For analyses of Target Compound List (TCL) components, instruments will be calibrated prior to the analysis of each batch of samples by analyzing known mixtures of the group of compounds under study as required by the appropriate analytical protocol. Instrument calibration will be verified daily as prescribed in the protocols. A new calibration curve will be established if the response observed in the analysis of the continuing calibration check standard varies outside of prescribed protocol limits.

8.2 Field Calibration

In addition to the laboratory analyses conducted during the course of this investigation, field measurements of pH, specific conductance, and temperature will be taken for ground water samples. Field Analyses of headspace over ground water for selected unsaturated volatile organic compounds will be performed. An air monitoring device (e.g., OVA, HNu, Microtip) will be used to analyze ambient air for potentially hazardous concentrations of volatile organic compounds.

The frequency of field calibration procedures will, at a minimum, include the following:

- The pH meter will be calibrated and the specific conductance meter will be standardized a minimum of twice daily or after every ten samples and documented in the calibrator's field book.
- The pH meters will be calibrated using specific techniques according to the manufacturer's instructions and two standard buffer solutions (either 4.0, 7.0, or 10.0). The pH values of these buffers will be compensated for temperature according to the values supplied on the manufacturer's bottle label. The temperature (measured as

below) at which the sample pH was measured will then be used to compensate for temperature on the meter.

- Temperature measurements will be performed using the thermometer function on the conductivity meter which is calibrated to a National Bureau of Standard (NBS) specification thermometer. Measurements will be recorded to the nearest °C. This level of accuracy is sufficient for the temperature measurements required by this project.
- Equipment for monitoring ambient air for volatile organic compounds (e.g., HNu, OVA, or Microtip analyzer) will be calibrated daily prior to use.

Section 9 ANALYTICAL METHODS

This section describes the analytical methods to be used during the Remedial Assessment and Performance Monitoring at the Medley Farm Site.

9.1 Laboratory Analyses

Volatile organic compound analytical procedures utilized during performance monitoring need to be DQO Level 3 and conform to the analytical methods described in US EPA SW-846. Ground water sampling rounds which will analyze for site-specific volatile organic Constituents of Concern (see PSVFSAP for details of the sampling and analytical program; see Table 9-1 for site-specific volatile organic Constituents of Concern) will utilize US EPA SW-846 Methods 8010/8020 modified to include acetone and 2-butanone. Ground water sampling rounds (one annually) that will include all TCL volatile organic analytes will utilize US EPA SW-846 Method 8260. Soil samples will utilize US EPA SW-846 Method 8260. In order to facilitate comparability between data acquired during the performance monitoring program to CLP data acquired during the RI/FS and completed portions of the RD/RA, the practical quantitation limits for these methods (i.e., US EPA SW-846 Methods 8010, 8020, and 8260) should be at or below the Contract Required Quantitation Limits (CRQL) defined in US EPA CLP protocols. The CLP CRQLs are presented in Table 9-1 for reference.

Samples of Soil Vapor Extraction (SVE) exhaust will be collected using an activated charcoal tube(s). The samples will be analyzed for compounds on Table 9-2 via gas chromatograph/FID using a NIOS 1500 based procedure.

Chronic toxicity tests of the ground water treatment system effluent will conform to "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA/600/4-89/001, March 1989), and "South Carolina Procedures for Pass/Fail Modifications of the *Ceriodaphnia* 48-Hour Acute Toxicity Test and *Ceriodaphnia* Survival and Reproduction Test" (SC DHEC, May 1989).

Additional analytical methods and parameters used to engineer the remedial design will be specified in the Remedial Design Work Plan. These would include such issues as scaling, precipitation, and corrosivity; and monitor parameters such as hardness, alkalinity, calcium, iron, and manganese, which utilize DQO Level 3.

TABLE 9-1
TCL AND SITE-SPECIFIC VOLATILE ORGANIC COMPOUNDS

TARGET COMPOUND LIST VOLATILE ORGANIC COMPOUNDS	SITE-SPECIFIC CONSTITUENT OF CONCERN	CLP CONTRACT REQUIRED QUANTITATION LIMITS
		WATER (µg/L)
Chloromethane	X	10
Bromoethane		10
Vinyl chloride		10
Chloroethane		10
Methylene chloride	X	10
Acetone	X	10
Carbon disulfide		10
1,1-Dichloroethene	X	10
1,1-Dichloroethane	X	10
1,2-Dichloroethene (total)	X	10
Chloroform	X	10
1,2-Dichloroethane	X	10
2-Butanone	X	10
1,1,1-Trichloroethane	X	10
Carbon tetrachloride		10
Bromodichloromethane		10
1,2-Dichloropropane		10
cis-1,3-Dichloropropene		10
Trichloroethene	X	10
Dibromochloromethane		10
1,1,2-Trichloroethane	X	10
Benzene	X	10
trans-1,3-Dichloropropene		10
Bromoform		10
4-Methyl-2-pentanone		10
2-Hexanone		10
Tetrachloroethene	X	10
Chlorobenzene		10
Ethylbenzene		10
Styrene		10
Xylenes (Total)		10

TABLE 9-2
VOLATILE ORGANIC COMPOUNDS INCLUDED IN
SVE EXHAUST MONITORING PROGRAM

Benzene
Chloromethane
Chloroform
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethene
Methylene chloride
Tetrachloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene

Section 10

DATA REPORTING, VALIDATION, AND REDUCTION

Data validation practices will be followed to assure that raw data are not altered and that an audit trail is developed for data which require reduction. Field data, such as those generated during field measurements, will be entered directly into a bound field notebook. The Technical Coordinator will review field measurements recorded in the field books. Project team members will be responsible for proofing data transfers.

The Laboratory Quality Assurance Officer will validate the laboratory analytical data before it is released. This effort will include an inspection to determine if the data meet the QA/QC criteria specified in each analytical protocol, and which are generically discussed in Section 3 of this PSVQAPP. Aspects of the data which do not meet applicable QA/QC guidelines, and deviations from established analytical procedures, will be documented in a narrative accompanying the data.

Analytical Data Reports will be available from the laboratory within four weeks following the receipt of the samples. Upon receipt of the laboratory data reports, the data will be checked by the Laboratory Coordinator or his/her designee. This procedure will involve the review of data, reporting units, laboratory method blanks, field blanks, trip blanks, rinsate blanks, the agreement between samples and duplicates, surrogate and spike recoveries, and the case narrative.

RMT anticipates that data reduction for this phase of the investigation will consist of tabulating analytical results from Analytical Data Reports into summary tables through the use of computerized database and spreadsheet software. Time versus concentration plots may also be created to visualize concentration trends. Reduced data will be placed in the central file maintained by the Project Manager.

Raw field specific conductance data will be reported as micromhos per centimeter (umhos/cm), and will be corrected to 25°C. The pH measurements will be reported as standard units, and temperature will be reported in degrees Centigrade (°C). Hardcopy analytical data will be reported in units consistent with the analytical method. Electronically deliverable data, if generated, will be in RMT's proprietary format and will have analyte concentrations reported in parts per million (ppm).

The data validation program will track investigation documentation so that it is available when the remedial investigation and design have been completed. Accountable documentation include items such as log books, field data records, correspondence, Chain-of-Custody records, analytical reports, photographs, computer disks, and final reports. The Project Manager is responsible for maintaining a file in which all accountable documents will be inventoried. Raw data generated during field operations will be filed to eliminate or correct errors arising from the transfer of data.

In order to avoid errors in the transfer of data, copies of raw data from the field notebooks and the data as received from the laboratory will be entered into a data file. The data file will serve as the ultimate archive for information and data generated during the performance monitoring.

Section 11

INTERNAL QUALITY CONTROL CHECKS

Internal Quality Control Checks of field activities will be utilized during this investigation through the use of the following:

- **Field Blanks** - These blanks consist of organic free, deionized water contained in each sample container with any preservatives required for that analysis. These will serve as a QC check on the field sampling methods for CLP analytes, container cleanliness, and external contamination. A field blank will be submitted for each sampling event.
- **Trip Blanks** - These blanks consists of organic free, deionized water contained in volatile organic compound (VOC) sample containers and preserved similar to VOC samples. These samples serve as a QC check on potential external contamination and/or cross-contamination between VOC samples during shipping and storage. A trip blank will accompany each cooler of VOC samples sent to the laboratory.
- **Rinsate Blanks** - These are samples of organic free, deionized water which have been in contact with decontaminated sampling and/or drilling equipment. These samples serve as a QC check on the field decontamination procedure. A Rinsate Blank will be collected bi-weekly (*i.e.*, alternate weeks) during each field event when on-site decontamination of equipment is performed.
- **Field Duplicate Samples** - Duplicate samples will be collected to allow determination of analytical repeatability and sample homogeneity. At a minimum, one duplicate sample for each ground and/or surface water sampling event, and one duplicate for every twenty soil and/or sediment samples, will be collected and submitted for analysis.
- **Matrix Spike/Matrix Spike Duplicate Samples** - A matrix spike/matrix spike duplicate (MS/MSD) sample will be submitted as a further QC check one quarter each year in association with those samples to be analyzed by GCMS (*e.g.*, SW-846 8260 methodology). MS/MSD samples will not be performed every quarter for ground water since the matrix has been shown to perform well during recent and current analyses. Matrix spike/matrix spike duplicate samples are actually laboratory analytical QC items which are discussed here because sufficient sample must be collected in the field in order to perform these analyses. These samples will allow the amount of recovery of spike compounds (the spike compounds are defined in the analytical protocols) to be determined for matrix effects specific to the study site, through the addition of known concentrations of compounds into the sample at the laboratory and then performing the analysis. The level of added constituent incorporated into QC samples will be consistent with the appropriate US EPA SW-846 analytical protocol. The frequency of matrix spike/matrix spike duplicate (MS/MSD) samples will be one per 20 ground and/or surface water samples, and one MS/MSD per 20 soil and/or sediment samples.

Extra volume of ground water will be collected at sampling points chosen for duplicate samples. Soil and sediment samples will be homogenized prior to placement into a clean sample container. Homogenization will be performed by mixing a soil volume large enough to fill the sample container (and duplicate and matrix spike containers, if applicable) on a stainless steel pan with a stainless steel trowel. This homogenization procedure is performed due to the tendency of soil samples to be nonhomogeneous with respect to constituent levels. Samples collected for volatile organic compound analyses will not be homogenized because of potential loss of analytes due to volatilization during the homogenization process.

Duplicate samples will be labeled in a manner such that their sampling point location is not disclosed to the laboratory. The duplicate sample number (e.g. DU-1) and its corresponding sample location will be recorded in the field notebook. Sampling date and time will not be filled out on the label of the duplicate sample nor on the Chain-of-Custody form in order to not to disclose the duplicate's sample point location.

Section 12

PERFORMANCE AND SYSTEM AUDITS

On-site audits may be performed to review field-related Quality Assurance activities. The audits would be conducted by the Technical Coordinator.

Specific elements of the on-site audit include verification of the following:

- Completeness and accuracy of sample Chain-of-Custody forms, including documentation of times, dates, transaction descriptions and signatures;
- Completeness and accuracy of sample identification labels, including notation of time, date, location, type of sample, person(s) collecting sample, preservation method used, and type of testing required;
- Completeness and accuracy of field notebooks, including documentation of times, dates, drillers' names, sampling method used, sampling locations, number of samples taken, name of person(s) collecting samples, types of samples, results of field measurements, soil logs and problems encountered during sampling;
- Adherence to health and safety guidelines including wearing of proper protective clothing. Level D protective clothing will be worn at a minimum and will be upgraded, if necessary, as specified in the Health and Safety Plan;
- Adherence to decontamination procedures as outlined in the site Health and Safety Plan, including proper washing or steam cleaning of pumps and pump tubing, bailers, and soil sampling equipment;
- Adherence to sample collection, preparation, preservation, and storage procedures as outlined in this Work Plan.

Section 13

PREVENTIVE MAINTENANCE

The maintenance procedures discussed in the following subsections will be performed to maximize efficiency and minimize downtime in the laboratory and while working on the Medley Farm site.

13.1 Laboratory Maintenance

Specific routine maintenance procedures, preventive maintenance procedures, and maintenance logs for the GC-MS system will be documented/maintained by the Laboratory. This documentation will be available for review if requested by the project staff or the Medley Farm Site Steering Committee.

13.2 Field Maintenance

Routine daily maintenance procedures conducted in the field will include the following:

- Removal of surface dirt and debris from exposed surfaces of the sampling equipment measurement systems.
- Storage of equipment away from the elements.
- Daily inspections of sampling equipment and measurement systems for possible problems (e.g., cracked or clogged lines or tubing; weak batteries).

Spare and replacement parts stored in the field to minimize downtime include the following:

- Appropriately sized batteries,
- Extra precleaned sample bottles,
- Locks,
- Thermometers,
- pH probes, and
- Buffer solutions.

Section 14

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION ACCURACY AND COMPLETENESS

14.1 Laboratory Data Quality Assessment

Chemical data quality will be assessed using analytical method-specific criteria and, where applicable, validation methods described in National Functional Guidelines for Organic Data Review (June 1991). Data qualifiers described in the latter document may be applied to the data if appropriate. RMT personnel will be advised of data having questionable or unacceptable quality and procedural deviations noted in the case narrative.

14.2 Project Data Quality Assessment

14.2.1 Laboratory Data Assessment

Data will be validated by the Laboratory Quality Assurance Officer prior to its release. The Laboratory Coordinator, or his/her designee, will conduct a second review of data as it is received from the Laboratory. This data will then be incorporated into the next routine monthly QA report that would be submitted to US EPA. The Laboratory Coordinator will check that data packages include a narrative to document variations from the analytical protocol and actions taken by the laboratory to address those variations.

14.2.2 Field Data Quality Assessment

To assist in collecting field data accurately and correctly, specific instructions will be issued by the Technical Coordinator to personnel involved in field data acquisition. At the end of each field event the Technical Coordinator will review the field books used by project personnel to check that tasks were performed as specified in the instructions. Field books will be reviewed periodically throughout the entire project.

Raw data and reduced data will be submitted by project personnel to the Technical Coordinator for review. Equations, calculations, data transfers, consistent units, and significant figures will be subject to this Quality Assurance review.

Section 15 CORRECTIVE ACTION

15.1 Laboratory Corrective Action

Corrective actions are required when an out-of-control event or potential out-of-control event is noted. The corrective action taken is somewhat dependent on the analysis and the event.

Examples of "out-of-control" events are:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks contain target analytes above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA Department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA Department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA Department.

The laboratory will provide documentation as to what, if any, corrective actions were initiated concerning this study and report them to the Laboratory Coordinator.

15.2 Contamination

For each matrix analyzed, the Laboratory Coordinator will review the data from the analysis of field, trip, rinsate, and method blanks. If excessive contamination (i.e., levels above allowable limits set within the

CLP protocols) is found in the blanks, corrective action will be taken, including requesting that the analytical laboratory:

- check raw data and calculations, and
- if the contaminating analyte is also present at high levels in field samples, repeat the analysis of the laboratory stored sample or sample extract.

If the contamination does not appear to originate at the laboratory, the Laboratory Coordinator, in conjunction with the Technical Coordinator, will review field sampling procedures to determine if a change in field sampling protocol is necessary.

15.3 Missing or Lost Samples or Data

The objective for completeness is 95 percent. If samples or data are lost during sampling and analysis activities, corrective actions will be taken, including:

- requesting that the analytical laboratory reanalyze stored samples or extracts, if available, and
- repeating collection and analysis of ground water samples.

Section 16
QUALITY ASSURANCE DOCUMENTATION TO US EPA

The Project Manager, in conjunction with the Project Coordinators and Laboratory Coordinator, will submit a project status report each month. This report may include the following types of information relating to Quality Assurance Activities:

- Significant irregularities noted in the field notebook during the sampling procedure.
- Results of performance and system audits, if conducted.

Pertinent quality assurance documentation will be submitted to the following person at US EPA:

Addressee:

Mr. Ralph O. Howard, Jr.
Remedial Project Manager
United States Environmental Protection Agency
Region IV - Waste Management Division
345 Courtland Street, N.E.
Atlanta, GA 30365